THE

ELECTRICAL REVIEW.

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THE

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THE MEANS AND END OF EDUCATION.

THE discussion which followed Prof. Perry's address on "The Teaching of Mathematics," delivered to the British Association at Glasgow on September 14th last, proceeded, unfortunately, much on the usual lines of destructive criticism, and we do not think it went to the root of the matter at that. It comprised a skirmish round the question of concrete *versus* abstract training, an attack upon and weak defence of Euclid's elements, and a wholesale denunciation of examination. Neglecting the first point of dispute, and admitting out of hand that we have no particular affection for the Alexandrian philosopher, we may still venture to doubt whether the ban under which his methods have fallen is altogether justified. If, by reason of the aversion shown by most people from original thought, and the facility they display in thinking illogically, we grant that majorities are always wrong, we are met with the antagonistic phenomena that the head masters of England plump for Euclid, while all the nations of the earth, save Great Britain, have cast him from his throne. But in spite of foreign example, it would seem that Euclid is to some extent bound up with the system of examination, partly because he is already in possession of a text-book, and partly because the intelligence with which he has been studied appears to lend itself with peculiar readiness to an examinational test. We are willing, nay, anxious, to admit that to test education by examination is theoretically wrong; to educate, or, in plain words, to "cram" a boy merely in such fashion that he may pass a board of examiners with little fatigue and flying colours is practically, as well as theoretically, absurd; and the more closely we approach so-called scientific subjects, the more plainly is the absurdity evident. But here we are met by the grave difficulty, that some test of education must be retained or devised. John Bull sends his son to the care of the Rev. Mr. Smith to school, desiring that he may obtain a better education than his father ever had. *Ex hypothesi* Bull is unable to estimate the value of the results; but, as a commercial man, and one of common sense, he must be assured he is receiving a good return for his money. As a matter of business, he cannot accept Mr. Smith's assurance on this point; and even Prof. Jones, or a board of Profs. Brown, Jones and Robinson, does not necessarily inspire him with confidence. But if Brown, Jones and Robinson are accepted, foolishly or not, by most people in the country as competent examiners, he will accept their verdict; and, what is more cogent, the firm into which Bull hopes to put his son will accept it too. The system is admittedly bad, for its utility depends on the common sense, rather than on the deep knowledge possessed by the board; and, unless the members of that board are demi-gods, they must, at least to a large extent, "standardise" their business. Nevertheless, before we can abandon all examinations, we must have something distinctly better to take their place.

We cannot help thinking that our whole method of education is wrong. We appear to want a scheme whereby every child shall be sent to a new, but more or less uniform, establishment in which two processes shall be simultaneously conducted under a mixed staff of trained teachers, and what, for want of a better term, we may call psycho-physiologists. The child shall be taught the "three R's" as the indispensable minimum and possible maximum, and during the operation the physiologists shall watch him carefully but unobtrusively until they can decide whether he has enough brain to be worth educating, and whether his body is sound enough to nourish that brain. If the verdict is adverse, let him go to the plough or the bench without delay. If he pass the test, let him proceed to a higher establishment, still under psycho-physiological supervision; and after several such weedings out, let him pass to the place or places where he can be trained to the utmost. The law of heredity and the doctrine of averages teach the same lesson: There is much greater probability that the son of an educated man will yield good value for education than that the son of the dock labourer will do so. Yet there are sports on both sides. The son of a philosopher may be an idiot; the son of the navvy a Clerk Maxwell. At present we are so afraid of missing the regenerate sport—which would be a dire calamity—that we squander time and energy over the degenerate variety and the infinitely commoner normal specimen of untrainable youth—which is more than equally sad. The whole of the country's money that is available for education is used up in giving a free training to the children of those very classes of the community from whom there is least likely to be any return; and so, except in Scotland, the fees demanded for middle-class and secondary education are heavy. The member of the upper middle classes is hunted with peculiar malignity by the tax and the rate collector; he is compelled to find the wherewithal to teach his servants' children French and art needlework; his own son must enter an office at 15 to keep his father out of the Bankruptcy Court. However much we may introduce machinery into the affairs of everyday life, there will remain a considerable quantity of manual labour to be performed—labour which requires nothing beyond obedience for its successful performance; and, therefore, till the millennium arrives we shall need the labourer, as the army still seems to need the private. There will always be hosts of individuals among us deficient in brain power, and multitudes of those still more unfortunate persons whose inherited diseases (including those of crime, insanity, and alcoholism) will prevent their using the brains they possess to the advantage of the nation. Why should we rob their luckier and more important brethren of the opportunities for the utmost mental culture, in order to give them a smattering of information useless and detrimental to themselves?

Of course, Prof. Perry's views on the teaching of mathematics are sound. It is obviously requisite that educational methods shall be modified to suit the student, while retaining sufficient uniformity to fulfil the requirements of the harmful but necessary examiner; and it is equally requisite that subjects shall be taught in such a way as to make them interesting—not so much in order that the said subjects may be remembered, as that a love of learning shall be cultivated. We have a lively recollection of a head-master, not a specially deep mathematician, who managed to introduce humour and interest even into his Euclid class, so that the boys understood what they were dealing with and looked forward with pleasure to the next proposition. But we do still assert that the primary end of education is not to teach things or subjects, not even to create a memory; the idea is to teach the learning faculty, and to train the brain to think logically. A man's brain should not be loaded up with facts and dates and operative processes (we mean the brain of a man of affairs or of a scientific consultant); the places for these are the shelves of his bookcase, and the library of the British Museum. His brain should be exercised and polished until it is capable of marshalling facts which he or his subordinate has collected from the books or the laboratory—marshalling them intelligently on the one side and the other until he sees whither the evidence points, until he can pass a sound and logical judgment on the problem submitted to him.

The Private Bill Reports.

Until very recent years the proceedings before the Private Bill Committees of the Houses of Parliament have been to a large extent concealed from the public gaze. Of late years we have published reports of the evidence adduced before the committees in support of the Bills dealing with electricity and electric traction which various promoters seek to pass through Parliament, together with a short note of such Bills as are passed unopposed. Except through channels of this kind, the Private Bills which are passed every year—sufficient in number and size to fill five or six bulky volumes—and the lengthy inquiries which precede them, are but little known to the public. No index of these Acts has ever been published. No record, except one which is accessible only to those who know their way about the lumber rooms at St. Stephens, is kept of the evidence, or of the names of counsel or witnesses. Of course, a shorthand note of the proceedings is kept in the Private Bill Office and is printed for the use of the parties, but copies are scarce, and exceedingly expensive to purchase. A new volume, entitled "The Private Bill Reports (Session 1899), Including Cases of *Locus Standi* in the House of Lords," has recently been published by Messrs. Eyre & Spottiswoode, under the editorship of Herbert Newton, Esq., barrister-at-law. This is the first of a series of volumes which will deal with all the private Bills of that year, while future issues will deal with the Bills of succeeding years. A work of a somewhat similar kind was published in 1896 by the same editor, but the volume under notice is the outcome of a much more ambitious scheme. It deals with all the private railway Bills passed or in any way considered in committees in 1899. Taking them in alphabetical order, all the Bills from the Aberdeen Joint Passenger Station Act down to the Great Western Railway Act may be found in the book. At the commencement of the book will be found a tabular statement showing at a glance the fate of each Bill in committee. The text of the work comprises:—(1) Abstracts of Bills, whether passed or thrown out. These abstracts are drawn up in such a way that the contents of the Act can be easily understood by anyone who is at all familiar with railway legislation. They also serve as a guide to anyone who is seeking for a precedent of a "protection" or other clause of an unusual description. Some of these abstracts were made by H. L. Ormsby, Esq., barrister-at-law. (2) Abstracts of the evidence given on the hearing of the Bills. Here the actual words of the witnesses are often given, the *dicta* of the chairman, and the decision of the committee. From a perusal of these an engineer, or the promoter of a private Bill, will be able to see the kind of evidence which must be put forward to satisfy a committee of either house. The arguments of counsel are also given at convenient length. At the end of each abstract the names of the promoters and opponents, their counsel and agents, are all set out. The volume is concluded by an index compiled by W. Valentine Ball, Esq., barrister-at-law. References may here be found to unusual clauses, and a list of all persons who are "protected" in any of the Acts dealt with in the volume is set out. We cannot but think that this volume will be useful to those who have to do with getting private Bills through Parliament. We learn that other volumes, dealing with tramway and electrical undertakings, are in the press, and venture to hope that there may be nothing to delay their publication. Any work which tends to diffuse knowledge of private Bill procedure may serve, in time, to diminish the expense which those who seek Parliamentary powers are so often, and so reluctantly, compelled to incur.

ELECTRIC EQUIPMENT OF CRANES.

By WILL RUNG, of Baden, Switzerland. Translated by W. PARK and J. LEHMANN.

(*Continued from page* 412.)

The Controller.—Special attention must be paid to the design and construction of the controller, as its requirements are often so numerous and so conflicting, that great difficulties present themselves to the designer. The controlling gear is subject mechanically to even rougher usage than the motor. The motors are placed close by the winch or the gear, beyond the reach of the driver, whereas the starting gear comes into contact with him, and is usually exposed to very rough treatment. The driver does not pay much regard to the careful treatment of the apparatus; he has all his attention concentrated on the load to be handled, and he carries out the movements of the controller without troubling himself in the least as to the possibility of damaging the apparatus; a badly constructed apparatus, therefore, very soon becomes absolutely worn out. Thus first of all rigidity and strength must be kept in view, and when it is not possible to combine strength and elegance in design, the latter must be regarded as a secondary consideration. Insulating materials, like marble, slate, &c., very popular indeed, and still extensively used by some makers, are as far as possible to be avoided, owing to their want of strength, and so are inflammable substances, or those liable to deteriorate with the heat from the starting resistance. The contacts of the resistances

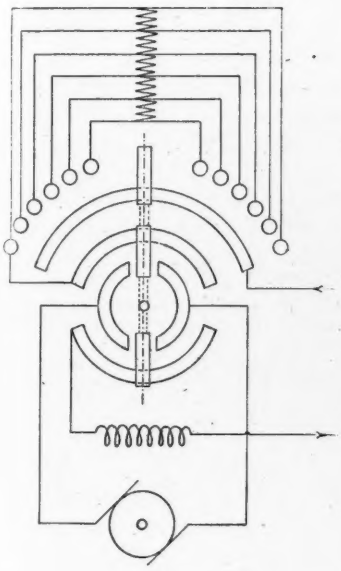


Fig 3.

Fig. 4.

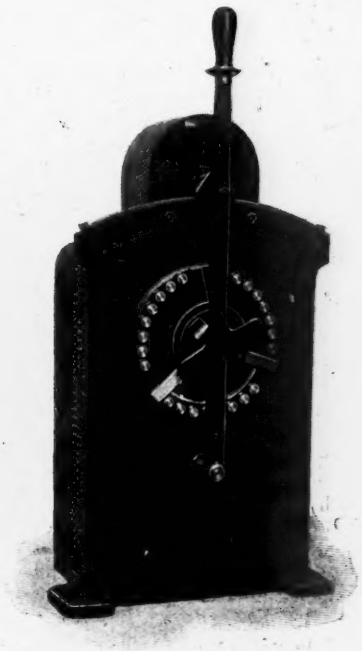


Fig. 5.

are among the parts especially exposed to wear and tear, being very rapidly eaten away by the sparking, which occurs over and over during the manipulation of heavy loads. Although the sparking cannot possibly be entirely prevented, the provision of a large number of contacts greatly reduces the damage. This method, however, increases the price rather seriously, and other arrangements have been sought for. For instance, small intermediate contacts, often made of carbon, have been added to the main contacts, the former not breaking the current until contact with the latter has ceased. In this way the secondary contacts, which must, of course, be readily replaced when worn out, take all the sparking. In the case of direct current supply, a magnetic blow-out has also been successfully used.

To facilitate the manipulations and to prevent the driver from carrying out wrong manœuvres, the starting switch and the reversing switch must be combined with the resistance in a single apparatus and worked by a single handle. The cut-out switch usually forms part of the starting or reversing switch. In the case of a direct current motor, the current can be broken, for instance, directly *viâ* the resistance. In the case of a three-phase motor the reversing switch can also be made to act as a cut-out switch. The resistance is to be so arranged that the same variation of resistance is obtained whether the handle be turned to the right or left of the off position. The direction of rotation of the motor is dependent on the backward or forward motion of the switch. As shown in fig. 3, this is easily obtained by the use of a number of contacts which are connected in pairs by the motions of the handle. The figure represents the connections for a series motor; the reversal of the motor in this case is brought about by transposing the terminals of the armature. This is more satisfactory than changing the poles of the magnetising coil, as it leaves the magnetism unreversed. The various connections are made by three springy contact pieces, fitted on a radial arm. The reversing is effected through the four interior contact bars. As may be clearly understood from the drawing, by moving the arm from right to left, the current will change its direction in the armature, but not in the magnetising coils.

Fig. 4 shows an apparatus embodying a somewhat different principle, made by Messrs. Brown, Boveri & Co., Limited, for a series motor. To get rid of the double row of contacts as used in fig. 3, and the corresponding numerous cable connections, a mechanical gear is provided so as to always turn the movable contact piece of the resistance in the same direction, when the handle is moved from its middle position to either side. But when the handle is moved from one extreme position to the other, the contact piece moves first in one direction, then in the opposite, so as to gradually introduce the resistance into the circuit again; and when the reversal of polarity has taken place, to gradually cut it out again. The circuit is broken by the contact spring leaving the last contact and passing over an insulated copper piece. The spark is blown out magnetically. The reversing switch works without sparking, the current always being switched off before the reversing occurs. The entire device is very strong but light. The switchboard is made entirely of cast-iron, and the insulation consists of ambroin and porcelain. The contacts are made of pure copper, this being far less liable to be damaged by sparks than brass. Larger apparatus is fitted with by-contacts made of carbon. The material used for the resistance is rheotan, which presents a large electric resistance, and possesses a large radiating power.

The same apparatus can be used, when the motor is required to rotate in one direction only, but to be capable of acting as an electric brake, as in the case of cranes, where the load can run down by itself, after the mechanical brake has been released.

To enable the speed to be controlled when lowering a load, the motor is made to work as a dynamo, sending the current through its own starting resistance. By cutting more or less resistance out of circuit, the speed is controlled with great ease; and by gradually short-circuiting the resistance, the load can at any moment be brought to a standstill. This method can be adopted straight away in the case of a shunt motor, whereas when a series motor is employed, the polarity of either the armature or the field must be reversed, as otherwise the motor would be demagnetised, and the driver would entirely lose control of it.

The apparatus used for shunt motors is similar to that for series motors. Reversing and starting are effected quite analogously, the sole difference being that attention must be paid to the extra current caused by the collapsing of the field when the circuit is broken, this current otherwise exposing the insulation to the danger of being pierced. Yet this risk is easily eliminated by providing a circuit through which the extra current can die away. For this purpose the starting resistance can be used itself, or a special resistance can be put in parallel with the field coil just before breaking the current. Often the shunt is left under current all day long, but owing to the waste of energy this method is not advisable. When allowing a shunt motor to act as an electric brake it is not usual to short-circuit the machine through its own starting resistance, unless it may be desirable to stop the motor very quickly after the current has been broken; when this is not the case, the descending load runs it as a dynamo, supplying current to the network and central station.

The speed of the direct-current motor is generally controlled by means of the starting resistance, the size of which should be substantial and the number of contacts considerable. If after having cut out the whole of the resistance it should be desirable to still further increase the speed, this can be effected by weakening the field in the same way as is usual on tramway motors. In the case of a series motor this can be done either by a variable resistance in parallel with the field winding, or by the system invented by Mr. Sprague, where the field winding is split up into a number of coils, which can be cut out one after another. For a shunt motor the usual arrangement is to put a resistance in series with the shunt. Another method, though rather complicated, is to divide the armature winding into two independent parts with which the ordinary series parallel control is used, exactly as in the case of two distinct motors.

The apparatus for three-phase motors is, as a rule, simpler than that for direct-current motors, and therefore handier. There are two quite distinct circuits—the stator circuit and the rotor circuit—the former having in series with it the combined cut-out switch and reverser, while the rotor circuit contains the starting and regulating resistance.

Fig. 5 shows a switch made for a 15-H.P. three-phase motor, by Messrs. Brown, Boveri & Co., Limited.

The reversing gear is combined with the cut-out switch in a single apparatus, placed directly above the resistance, and this combined switch is prevented from moving independently of the resistance by being connected through a fork to the lever working the latter. A spring fixed to the shaft ensures a very quick break whereby the break spark is considerably diminished. The reversing is effected by interchanging two of the stator leads. The contacts of the resistance are arranged in one row only, and the motion of the contact piece is similar to that described in connection with direct current apparatus. The resistance itself consists of rheotan wire, and to obtain good ventilation the surrounding case is made of perforated sheet-iron. The three-phase motor is controlled in the same way as the direct current motor, namely, by means of the starting resistance, the action in the two cases, however, being entirely different. In the case of a direct current motor the resistance diminishes the pressure between the two terminals of the motor, whereas in the case of a three-phase motor a resistance put in series with the rotor circuit augments the lag between the current in the rotor circuit and that in the stator circuit, in such a way that the number of revolutions decreases.

Another method of controlling, whereby the motor is run with a varying number of poles, is of too complicated a nature to be of use for running cranes.

In consequence of the intermittent running of a crane, the starting resistance is a most important part of the equipment. The consumption of current during starting depends on the design of the resistance as well as that of the motor. The action of the motor during the starting depends so much on the amount of resistance switched into the circuit and on the way the resistance is divided up, that this matter is worth considering somewhat more fully.

The minimum value of the total resistance is usually fixed so as to prevent the current at the moment of starting from exceeding the full load current, and so may be expressed in ohms by dividing the pressure between the terminals by the full load current. Yet a larger amount of resistance is advantageous, especially in the case of large motors, in order to prevent the occurrence of too great rushes of current in the supply mains, and to allow the governor of the engine or turbine time to deal with the variations of load. Thus if fully loaded the motor will not start until the resistance has been gradually diminished to such an extent that the necessary starting current is obtained.

(*To be continued.*)

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Concluded from page* 429.)

Specimen Long Distance Electric Transmission Specifications.

The specifications here reproduced for the 1892 project are interesting.

Specification of 10,000-*H.P. Electric Power Transmission Plant from the Yorkshire Coalfields to the Metropolis: Length,* 192 *kilometres* (120 *miles. See map.*)

C. E. L. Brown, of Brown, Boveri & Co., Baden.

Power Generating Plant.—Twenty Otto cycle gas-engines of 500 to 600 H.P., each arranged so that when the latter are working at their maximum load and the whole 10,000 H.P. is required, there are still three engines in reserve; engine speed to be 160 revolutions.

Electric Generating Plant.—Twenty (two-phase) alternating current machines, each for 600 H.P., together with their transformers, for stepping up the current to 20,000 volts.

The generating machines would be regulated by exciter current governors, and so arranged that there is one governor to each electric generating machine, capable of governing its own generating machine alone, or of being coupled up by means of a hand wheel on the switchboard, to act in common with the other governors.

Exciting Machines.—Three continuous current electric generating machines to act as exciters, of 120 H.P. each. Two of these exciting machines are capable of exciting 20 of the alternating generators. Each exciter would be coupled up to a separate gas engine of suitable power.

Switchboard.—Switchboard, containing all the necessary apparatus for measuring, regulating, and safety purposes.

There will be a double switch, a double lead safety fuse, an ampere meter for each group of engines, a voltmeter, the requisite parallel shunting apparatus, and, in addition, a general ampere meter for the whole installation, as well as a general volt meter.

Trunk Cables.—Cables to be 192 kilometres long (120 miles), rigged overhead, to be four in number, of a section of 300 square millimetres. The total loss of efficiency in the entire length of cables is estimated at 20 per cent. It is desirable to split up the four mains into six wires, each of 8 millimetres diameter; so that in all there would be 24 wires each having a sectional area of 50 square millimetres.

Secondary Transformers.—The transformers to have a capacity of 5,400,000 watts. The total cost of the plant specified may be taken at £53,000 without cables and erection. The total efficiency of the system will be 70 per cent. Including the cables the cost will be £250,000.

The Specification of the Maschinen Fabrik Oerlikon. South Yorkshire to the Metropolis.

Electric Generating Machines.—Five generating machines, with one in reserve erected on the Triphasic alternator system, each

machine being of 2,500 H.P., with a speed of 350 revolutions. The horizontal axis of machine to permit of direct driving.

Exciting Machine.—Two exciting machines, with one in reserve, each capable of exciting four generating machines. The exciting machines to be on the shunt principle, and to have an output of 158 H.P., giving 1,600 amperes at 75 volts, with a velocity of 400 revolutions per minute.

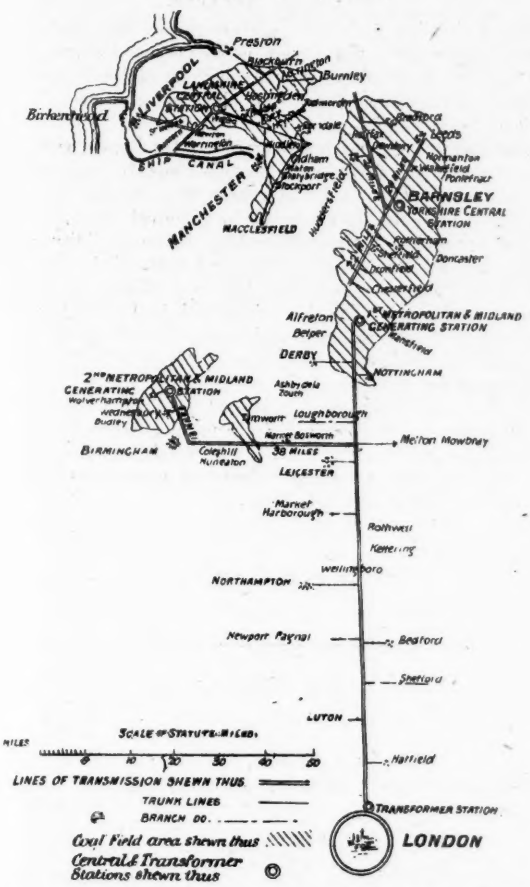


FIG. 27.—METROPOLITAN AND MIDLAND POWER TRANSMISSION SCHEME.

Transformers.—Ten transformers (with two in reserve) for triphasic currents, each of a capacity of 850 KW., and each one capable of elevating the tension up to 25,000 volts.

Commutation Tables.—Five commutation tables, with the controlling apparatus for safety and measurement controlled therein, as well as the conductors and the insulators for the installation of the generating station. Efficiency of the generating station, 90 per cent.

Lines of Transmission.—High tension, with a total capacity of 6,714 KW., corresponding to 10,000 H.P., to transmit at a distance of 120 miles, with a loss first of 20 per cent., and second of 30 per cent.

First, with a loss of 20 per cent. at an initial pressure of 20,000 volts, three conductors of a section of 360 mm², corresponding to 12 conductors of a section of 90 mm².

Second, with a loss of 30 per cent., three conductors of a section of 240 mm² corresponding to nine conductors of a section of 80 mm².

Oil insulators on the Oerlikon system to be adopted as applied at Frankfort, as well as the necessary safety and regulating arrangements. Total cost of electric part, including transformers, is made up as follows:—

Electric plant of generating and transformer stations	£36,000
Conductor trunk line (120 miles) with 20 per cent. loss	153,000
Total	189,000
Cost of power plant	85,800
Total	£274,800
Then add for contingencies	60,000
Grand total equals	£334,800

Very few modifications of these specifications published in the author's 1892 paper, except in relation to the magnitude of the power of the primary generators and increased line pressure, are absolutely necessary.

In the original project the author specified gas-motor units of 300 E.H.P.; the recent development of large power internal combustion engines permits with safety the increase of this form of power unit up to 2,000 KW.

An ideal scheme of power generation with three-phasic alternating gas-driven generators would be made up of power units of 2,000 KW., with a provision of step-down units permitting generators on the drop of the load to be worked always at full power. These step-down units would be made up of two 1,000-KW., two 500-KW., and two 250-KW. units. Mr. C. E. L. Brown writes to the author as follows:—

"When drawing up the (Brown-Boveri) specification in 1892, I proposed what was at that time the largest size of unit available, but now that gas engines of 1,000 H.P. and upwards are on the market, I should recommend the adoption, if possible, of units of from 2,000 to 3,000 H.P. My reason for advising the use of such large generating sets is that I consider that the capacity of 10,000 H.P. would only represent the power which it is intended to transmit at the outset of the undertaking, and that once the scheme was carried into execution, the capacity of the transmission would be increased very considerably, since I do not think it would pay to transmit 10,000 H.P. only over such a long distance as 120 miles.

"Coming now to the question of the system, I would say that I should give the three-phase system the preference over the two-phase, as it gives the smallest loss for a given weight of copper in the line.

"As the line is of considerable length, it is expedient to choose as high a tension as possible, and I should therefore recommend 25,000 to 30,000 volts, as recent practice has shown that, given favourable climatic conditions, this tension can be successfully worked with."

SCHEME OF MOTIVE POWER GENERATION.

For the gas-generating plant the author would prefer to utilise a combination of the best form of Westphalian coking-oven with cupola gas generators, combining the effluent gases from the coke ovens with gas generated (from residual or inferior coke) in the cupola gas producers in such a way as

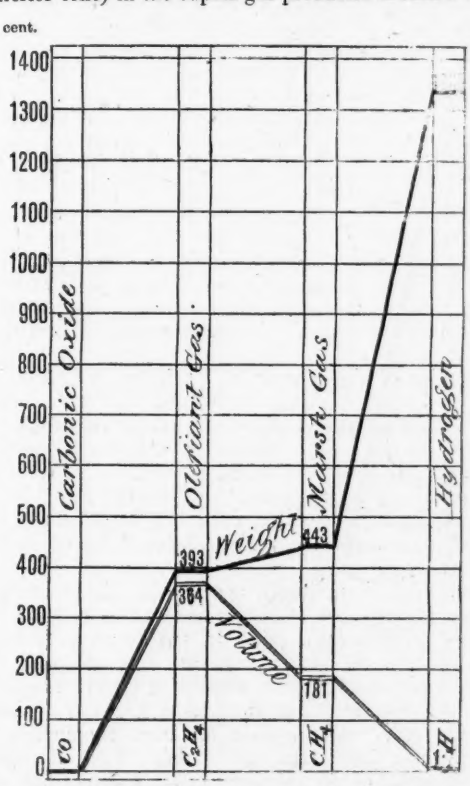


FIG. 28.—COMPARATIVE HEAT OF COMBUSTION OF GASES IN PERCENTAGE OF THAT OF CARBONIC OXIDE, BY WEIGHT AND VOLUME.

to keep down the proportion of the hydrocarbons as low as possible. These constituents are a great disadvantage, because they make it almost impossible to obtain sufficiently

steady running for alternator driving, unless they do not exceed a small percentage of the total.

The graphic diagram, fig. 28, shows the effect of the weight addition of hydrogen and hydrocarbon on the calorific value of the gas; the slightest variation of these chemical agents means a great increase of power production and consequent considerable fluctuation of the pressure established behind the piston, and nice power regulation becomes impossible.

The graphic diagram also shows that hydrogen, owing to its volumetric lightness, has little calorific advantages over the volumetric weight superiority of carbonic oxide, whilst the oxidation of hydrogen involves a thermal loss greater than does that of CO, unless the former is condensed to water.

The ideal fuel gas for power generating purposes is one containing only sufficient hydrogen to assist ignition of the explosive charge, and of hydrocarbons only such proportion as will not interfere with the uniformity of power production. The major part, 30 per cent. by volume, of CO, should constitute the basis of calorific production.

The Generation of Power Gas.

The 1892 project included the recovery of the tar and ammonia from the power gases, and any scheme of power production on a great scale, should include plant for the ammonia and tar recovery, but this condition should be only subsidiary to the main purpose of the gas generating plant, which should be to generate a gas perfectly suitable for three-phase alternating driving, and relying on its carbonic oxide content for the production of the required calorific effect.

The only steam that should be employed, would be that necessary to obtain the maximum recovery of the ammonia and tar, without involving the reduction of the CO content proportion of the power gas.

It may be assumed that coals containing 35—40 per cent. of volatile matter will provide recoverable tar to the extent of 115—120 lbs. of pitch, and 7—10 gallons of tar oil. The coal will contain 1·2 to 1·4 per cent. of nitrogen, of which 15 per cent. will be evolved in gaseous form, and is recoverable as ammonia sulphate. Some 23 to 25 lbs. of sulphate of ammonia will thus be recoverable from this highly hydrocarbonaceous coal.

By the addition of steam added to the fuel in the gas generating process, it is possible to obtain a very considerable augmentation in the weight of ammonia produced, but this would involve a considerable reduction of the value of the gases produced for power generating purposes. Of course, the project would only involve the treatment of the effluent gases from the coke ovens, for the recovery of the tar and ammonia, and, therefore, the cost of the by-product recovery plant would be very small compared with that necessary for the treatment of all the gases generated in the gas producer.

The value of the recovery of the by-products from hard splint coal used in blast furnaces is in normal conditions of trade equivalent to some 3s. 6d. per ton of coal, and the cost of the treatment plant would be equivalent to 5s. 6d. per ton of coal treated per annum.

A power generating plant of even 10,000 H.P. only would financially justify the establishment of a plant for recovering the tar and ammonia, the latter in the condition of ammonia sulphate.

From what has already appeared in the Electrical Review, granted that an ironworks (with at least two blast furnaces in operation), exists in the centre of a field of electrical power distribution, we have here an almost ideal source of power for driving alternating current machinery. The author harnessed blast furnaces to electrical machinery six years ago, and the plant has been running nightly during this time; the gas from these furnaces is also denuded of its nitrogen and hydro-carbon compounds, so that the application constitutes a very practical precedent. The author has a project under consideration for power production which includes the establishment of an ironworks in which the furnaces will be driven with warm blast, and all the gases available will be used for generating electrical power for distribution to the electric light stations of a large European city; in such an application the iron becomes a secondary product. The fact (already pointed out by the author in 1897) that British blast furnaces are more or less centrally located in manufacturing centres, gives us an advantage not possessed in the same ratio by any other manufacturing country.

Concluding Remarks.

The author has made very little reference to continuous current machinery; the subject is so very well known, and the fact that he considers the polyphase system will become generally used, except for special electrical processes, is the apology for the omission.

Furthermore, he has not referred to the booster system; no doubt the near future may provide practical applications of this innovation, and the results may permit valuable conclusions to be drawn as to its practical value. One of the triumphs of the last century is the rapidity with which the system of generating and transmitting energy over long distances has grown into a condition of almost perfect maturity. Alongside this growth is the development of power from internal combustion engines, which has proceeded in parallel lines, and already gas motors of 1,000 E.H.P., developing an efficiency twice as great as the best steam engines, can be confidently relied upon. The development of the latter has entirely sprung from the author's invention of 1894, by which it was proved to be possible to recover for power purposes the enormous volumes of waste gases issuing from iron making blast furnaces.

TROLLEY WIRE PROTECTION IN SANTIAGO DE CHILE.

The trolley wire system of electric traction, recently established in Santiago, is, in proportion to the size of the city, probably one of the most extensive systems yet constructed. The Chilian Electric Light and Tramway Company, Limited, has obtained a concession giving it permission to lay its lines through all the principal streets of the city, and even along all sides of the principal square (Plaza) in the very centre of the busiest traffic.

As there are two telephone companies with overhead wires, and several cable and telegraph companies, as well as the State telegraphs, whose systems are overhead, the question of contact between these wires and the trolley wires of the Traction Company is one which is causing considerable anxiety. There have already been several accidents in which horses have been killed by contact with falling telephone wires, in consequence of which the Municipality has contemplated ordering all overhead telephone and telegraph wires to be placed underground.

Some of these undertakings, however, have such a struggle for existence, owing to the financial conditions of the country, that such an order would mean their disappearance, and, therefore, the matter was last year referred to a committee, composed of the Director-General of Public Works, one of the engineers of the same department, and the Professor of Technical Physics, Mr. A. E. Salazar, of the Chili University.

This committee examined the various devices suggested by engineers in Europe, especially that of M. R. Ulbricht; the system adopted at the experiments in Bielefeld, Germany; and that of Mr. Quin, Blackpool.

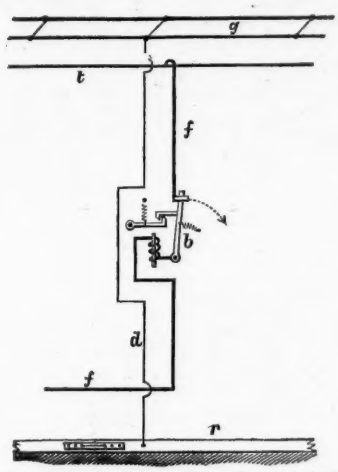
Finally the Committee decided that the only effective system is that in which the guard wire is earthed to the rail, which, as is well known, has already been tried successfully in Europe, and has obtained the approval of the Board of Trade.

The traction company objected to this system, on the ground that its poles would not carry the extra weight of the heavy guard wires required, and also because their whole system would be subjected to a severe shock in case of an accident.

Prof. Salazar therefore devised an arrangement which is very interesting, and worthy of the attention of traction

engineers. It is practically a modification of the usual system; the two arrangements are shown below, in order that the modifications of Prof. Salazar may be more readily seen.

Fig. 1 shows the usual arrangement with the guard wire direct to the rail.



t, Trolley wire; *g*, Guard wires; *r*, The rails; *b*, Automatic circuit-breaker, working by excess of current; *f f*, Section feeders.

Fig. 1.

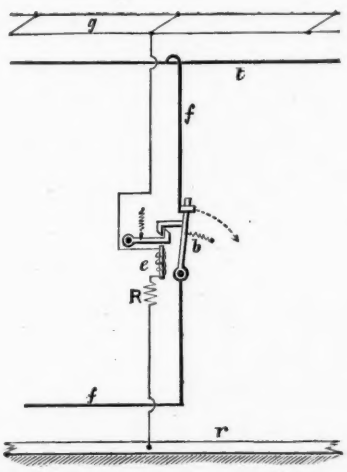
The disadvantages of this arrangement are:—

1. Working with an indefinite current, which might rise to a great number of amperes.

2. The guard wires must be of high conductivity and of relatively large sectional area, in order that they may not be fused by the current which they may eventually have to carry.

3. The whole installation is put to a severe test in case of an accident, especially in the case of a large number of falling wires.

Fig. 2 is Prof. Salazar's modification. The guard wire is connected to the rail through a definite resistance.



t, Trolley wire; *g*, Guard wires; *r*, Rails; *c* and R, Electro-magnet and additional resistance, which can be reduced to 250 ohms; *b*, Interrupter of the section feeder, independent of the same.

Fig. 2.

The advantages of this arrangement over the former are as follows:—

1. Certain action with a predetermined current ($\frac{500}{c + R}$).

2. The guard wire need not be of high conductivity, nor of great cross-sectional area, as the current cannot exceed 0·05 to 2 amperes.

3. Independence between the circuit breaker and the main feeder, *i.e.*, the section feeder is protected.

4. This arrangement does not operate by excess of current, and therefore neither the fuses nor cables, nor any other part of the system feels the result of the accident.

5. The facility with which the working may be re-established after an accident, as there are no fuses to replace, the breaking lever being merely restored to its normal position.

The resistance interposed may vary between 10,000 and 250 ohms, the ampere-turns in *c* remaining constant, provided that the electro-magnet has sufficient strength to attract the armature.

In the first case there is the inconvenience of a slight shock to a person touched by a fallen wire; but by reducing the resistance to 250 ohms not even the slightest shock would be experienced by a person whose body might be interposed between the rails and a falling wire, the human body opposing a high resistance.

This device has been subjected to a series of tests before the various engineering bodies of Santiago, the results having been in every sense successful. The Municipality of Santiago, which is the controlling authority over all public undertakings in the city, has issued a decree commanding the Chilian Electric Tramway and Light Company to protect their trolley wires throughout, and this method of protection will doubtless solve the problem as far as possible, until the telephone and telegraph wires are placed underground.

ENGLISH AND AMERICAN RAILWAY SIGNALLING.

By J. PIGG.

The subject of railway signalling seems to be one in which considerable interest is taken outside purely railway circles in the United States. That this is so is shown by frequent articles on the subject appearing in publications issued by educational institutions. Some time ago a most interesting, illustrated, descriptive article on American practice, from the pen of Mr. J. P. Coleman, appeared in the *Wisconsin Engineer*, and a most readable article on the same subject appears in the 15th Vol. of the *Technograph*, an annual issue of the Illinois University, by Mr. F. J. Postel, of Chicago. Much of the same ground is covered by the two articles, and from them we are able to form an opinion of the progress of signalling, and its present position in the States.

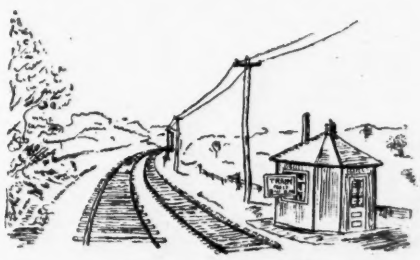


Fig. 1.—Train Board.

The development of railway signalling in America seems to approximate closely to that in this country, to a certain stage, in that both show a tendency to impose checks upon the actions of the controllers of the traffic. In that Continent of labour-saving devices, however, much greater progress seems to have been made towards automatic working than is observable in this country, or is likely to be for a very considerable time. Signalling practice in this country has been standardised, or practically so, for a considerable number of years. English railway officials, some 30 years ago, admitted the advantages of the block system as we know it, and the principal companies adopted it forthwith; so that, practically, railway signalling is uniform throughout the country, in so far as the principle of the system is concerned. How far the action of the Board of Trade may have conduced to this result is perhaps a matter of opinion. It is, however, to the credit of the railway companies that when the Board

of Trade made the block system compulsory in 1889, most of the lines were already equipped, and many of them had been for years.

In the States, however, practice has not yet crystallised, and trains are signalled in a variety of ways. The "train despatcher," with or without the assistance of a system of local signalling by telegraph, is the controller of the greater part of the traffic. Moreover, it is not so very long since the regulation of trains by the time limit was abandoned on one, at least, of the great trunk lines. Flags, lanterns, explosives, and time flares were some of the early methods of signalling to following trains. Time boards (fig. 1), showing the time at which the preceding train passed that point were hung from small cabins at intervals along the line, as a guide to drivers of the supposed condition of the

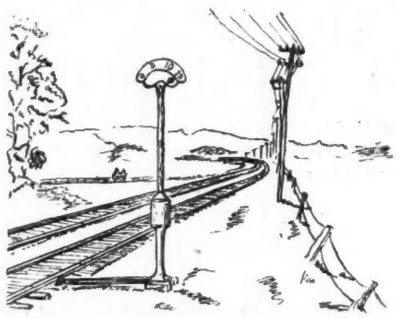


Fig. 2.—Dutch Clock.

line ahead, and the position of the preceding train. For a similar purpose, what were known as "Dutch clocks" were also used. These consisted (fig. 2) of elevated dials, over which a pointer was capable of being moved by a train passing over a mechanical treadle. The dial was graduated in 15 divisions, and the normal position of the pointer was on the 15th. The pointer was thrown over to zero by the passage of a train over the treadle, and, when the train had passed, the pointer moved gradually back to 15, taking 15 minutes to accomplish the movement. Hence the driver of a train approaching such a signal knew, from the position of the pointer, the time margin—up to 15 minutes—between his own and the preceding train at that point.

Fig. 3

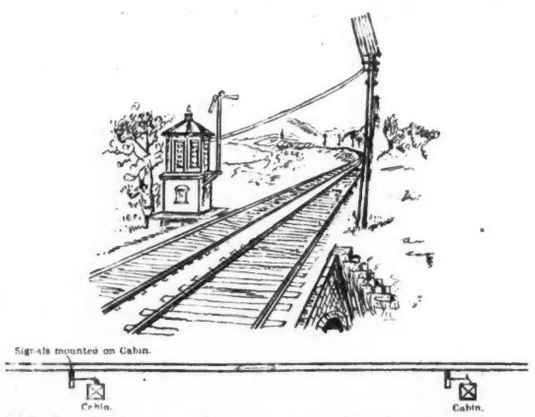


Fig. 3A.—Diagram of Equipment for Telegraphic Block System applied to Single Track.

Naturally such methods of protection became insufficient as traffic grew, and the train despatcher, with the aid of the telegraph, took in hand the guidance of traffic from a fixed point, and over a specified division. The division was parcelled out in "blocks" or sections, and the principle of one block one train was adopted. The dividing points of the blocks—usually the stations—were placed in communication with the train despatcher and with each other on a through wire. The arrival and departure of all trains are telegraphed to the train despatcher from each station, and it is his business to keep track of the position of each train in his division, and to transmit such orders as may be necessary to the various stations from time to time, for the control of the trains according to schedule, or to effect such alterations in the running order as may be necessary or desirable for reasons known to him alone. Such orders are taken by the station master and acted upon accordingly; and in order to minimise the chance of error, the orders received from the train despatcher are repeated and certified by him if correctly repeated.

Where so much line consists of a single pair of rails only, the duties of the train despatcher are of the highest order of importance. He, and he alone, is responsible for the direction of the trains. If a train is to be shunted to allow another to pass in the opposite direction, he must give the

Fig. 4

order as the train approaches the point at which the crossing is to take place. Naturally the train despatcher is very much in the hands of the person whom he instructs to more immediately deal with the train, and instances are, apparently, not wanting in which misapprehension of orders, or neglect to carry them out, have had serious consequences.

A development of the train despatcher system is that known as the "Telegraphic Block," which consists of the local telegraphing of trains in addition to the ordinary communications with, and control by, the despatcher, figs. 3 and 4. The system provides for the local "blocking" or stopping of trains passing from "B" to "A," say, when the despatcher has authorised the despatch of a train from "A" to "B" (on single line). The departure of the train from "A" is telegraphed to "B" and also to the train despatcher. "B" orders "C" to "block" for him, *i.e.*, stops the passage of trains from "C" to "B." On the arrival and departure of the train from "A" to "B," the latter notifies the despatcher and "C," and the latter orders "D" to block for him in the same way, and so on throughout the sections or "blocks." Sometimes these operations are all carried out on the through

Fig. 5.—Diagram of the Early Equipment of Manually Operated Systems automatically controlled by Trains.

wire with which the despatcher is connected, and he is thus enabled to check the local "blocking." In other cases, and apparently preferably, the local signalling is carried out on local circuits extending from one station to the next. The system also requires that the passing of a train out of the limits of the block be notified to the station in the rear before the latter allows another train to proceed in the same direction. "This system is probably used on more lines of railroad than any other. The reason for this is its cheapness and effectiveness." Thus one writer. Another characterises it as dependent "upon weak humanity," and says instances are not wanting of neglect to put signals to danger behind trains, and of misinterpretation, or non-delivery of messages.

The defects of such a system are apparent, and we find that attempts to obtain concerted action were made by providing electric locks on the signal levers, so that the operator at the advance cabin alone could release the lever controlling

the passage of a train towards that point. This arrangement, whilst ensuring against the despatch of a train without the knowledge of the operator whose position it was approaching, did not ensure the restoration of the signal to the danger position behind trains. To obviate this defect the operations were made cyclic, and were such, that when one operator released the lever of another, the device by which the release was made was so constructed and con-

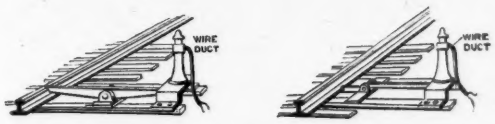


Fig. 6.—Early Treadles used for Controlled Manual System.

trolled by the releasing operator's lever, that a reversal of *that* lever was required for each operation of the releasing instrument. Hence, after releasing the signal lever at the rear cabin, the operator had of necessity to lower his signal, and put it to danger again, before he was able to release the lock at the rear cabin again.

Still further control seemed to have been considered necessary, since it was still possible for an operator to replace the signal to danger before the train for which it had been lowered had passed, and to take a second train behind the first. To meet this case the arrangement was altered, so that the operation of the releasing instrument was governed by the train itself. The releasing apparatus was arranged so that it could be operated but once for each train passing through the block controlled by it, and then only on con-

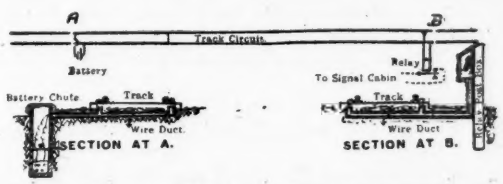


Fig. 7.—Diagram of Track Circuit Arrangements for Controlled Manual System.

dition that the signal of the next succeeding block had been restored to danger behind the previous train. Such a system constitutes the "Controlled Manual," which is extensively used in the States, and which derives its name from the fact that it is a manually operated, automatically controlled system (fig. 5).

In the early days of the controlled manual system, the check offered by the train on the actions of the operator was removed by the operation of treadles, such as are shown by fig. 6. Such treadles were found difficult to keep in order, owing to the heavy blows to which they were sub-

Fig. 8.—Diagram of Complete Signalling Arrangements for Controlled Manual System. Trains run on right-hand track. Signal arms project to the right.

jected. The "track circuit" was devised to meet this objection to the use of treadles. The "track circuit" consists of an insulated section of rail which, with one or two cells connected at one end, and a relay at the other, forms a closed circuit (figs. 7 and 8). The rails constituting the track circuit are insulated from other parts of the line by the removal of the ordinary fish-plates and substituting lengthy blocks of wood. In other cases, however, the ordinary fish-plates are retained, but are carefully insulated from the rail. Obviously a train entering upon such a section of the line will short-circuit the battery and cause the relay to become inoperative, and thus cause a corresponding change in the circuit operated by the relay.

(To be continued.)

HIGH-POTENTIAL SYSTEMS OF TRANSMISSION.

At the recent meeting of the American Institute of Electrical Engineers, quite a large number of papers were read and discussed, all of which treated of questions of great timely interest to the electrical engineering profession, and quite a number dealt with high-potential systems of transmission, and referred specially to branches of electrical work of which English engineers have had little or no experience. The president, Mr. C. P. Steinmetz, read an exceedingly valuable paper on "Theoretical Investigations of Some Oscillations of Extremely High Potential in Alternating High-Potential Transmissions," from which we derive the following remarks:—

When a circuit possesses capacity, any change in the circuit conditions, such as pulling a switch, extinguishing a short circuit, or starting up a generator, involves the production of electric oscillations which may be very rapid, and result in a destructively high potential. The paper contains an account of observations made by Mr. Steinmetz, and an exhaustive mathematical investigation of the character of the electric oscillations under consideration. He remarks that the first time he noticed such phenomena was when making a series of observations on the effect of opening a high potential circuit with different types of circuit breakers, on an artificial line consisting of inductive coils and about half a mile of high potential cable, with a spark gap between needle points connected across the system to measure an instantaneous rise of voltage. If the needle points were brought so close together that a discharge occurred between them, an extremely high voltage was invariably induced locally in the system, of a total striking distance reaching as high as 40 in., or between one-quarter and one-half million volts, the normal voltage of the system being about 10,000. The explanation of this phenomenon is probably as follows:—By striking between the needle points shunting the circuit the system was short circuited, and thus instantly drained of its electrostatic charge, so that the potential locally fell to practically nothing, while an excessive current passed between the needle points as arc. By the heating effect of this current the arc was instantly blown out explosively, and thus the short-circuit current of the system ruptured. After the explosion, the discharge between the needle points again short-circuited, interrupted itself, &c. The phenomenon is thus of similar character, but infinitely greater power to the action of the Wehnelt interrupter (the latter depending upon the combined effect of self-induction and electrolytic polarisation), while the phenomenon observed occurred with self-induction and capacity. Steinmetz also observed that a short circuit in a constrained space, as in a buried cable, does not appear to give this effect.

The author completes the paper with the following conclusions:—

1. The most important sources of destructive high voltage phenomena in high potential circuits containing inductance and capacity are not resonance phenomena from the wave of impressed E.M.F., or its higher harmonics, in case of the deviation of the wave from sine shape, but are electric oscillations produced by a change of circuit conditions, as starting, opening circuit, &c.

2. These phenomena are essentially independent of frequency and wave shape, and of impressed E.M.F., but depend upon the conditions under which the circuit is changed, as in the manner of change, and the point of the impressed E.M.F. and current wave at which the change occurs.

3. The electric oscillations occurring in connecting a transmission line to the generator are not of dangerous potential, but the oscillations produced by opening the transmission circuit under load may give rise to destructive voltages, and the oscillations caused by interrupting a short circuit are liable to reach voltages far beyond the strength of any insulation. Thus special precautions should be taken in opening a high potential circuit under load. But the most dangerous phenomenon is a low resistance short circuit in open spaces.

4. The voltages produced by the oscillations in open circuiting a transmission line under load, or under short circuit,

are moderate, if the opening of the circuit occurs at a certain point of the E.M.F. wave. This point approximately coincides with the moment of zero current.

The paper includes several numerical examples, which are worked out to illustrate the effect of the oscillations. In one of the examples given a transmission line operated at 20,000 volts is considered; the full load current was 100 amperes, the resistance drop 8 per cent., the inductance drop 15 per cent., and the charging current 8 per cent. of the full load current. The resistance drop in the step-up transformers was assumed at 1 per cent., and the reactance voltage at $2\frac{1}{2}$ per cent. The total resistance drop in the line and both sets of transformers would be 10 per cent., and the total inductance voltage or drop 20 per cent. of the impressed E.M.F. Under these conditions the rise in voltage, due to rupturing the line under short circuit, would be 282,800 volts maximum, the maximum impressed E.M.F. being 28,280 volts, *i.e.*, the rise in voltage would be tenfold.

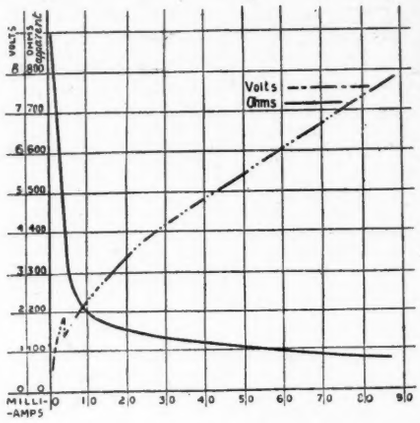
A paper on "The Elements of Design particularly pertaining to Long-Distance Transmission," was read by Prof. F. A. C. Perrine, and it was pointed out that the most important element in long-distance transmission is regulation, which is but slightly affected by the resistance of the line compared with the effect of capacity, which is undoubtedly the predominant factor in long high-voltage transmission lines. With variable loads capacity reactance cannot be made to constantly neutralise inductive reactance, since the former is constant, while the latter varies with the load. Prof. Perrine pointed out that by far the most important effect of capacity in a circuit is that which relates to the regulation of the transformers and generators connected to the line, since a leading current taken from such apparatus has the effect of decreasing the voltage, while a lagging current increases it. He also mentioned the very large charging currents involved with high voltages, which render commercially impossible the transmission of a smaller power than about 3,000 KW., unless the capacity of the line be neutralised by means of inductance. He further remarked that electrical tension, resulting in brush discharges, renders the use of wires smaller than $\frac{3}{8}$-in. in diameter, for lines operating at 50,000 to 60,000 volts, dangerous practice, involving important energy losses from these discharges, independent of leakage over the surface of the insulators.

CORRESPONDENCE.

The Electrical Resistance of the Human Body.

On my return after some weeks' absence, I notice in looking through recent numbers of the ELECTRICAL REVIEW, the reprint of a paper* by W. L. Hooper on the above subject. This article contains the following:—"With the Wheatstone bridge and cell the resistances were always high, usually from 20,000 to 40,000 ohms; with the milliammeter and voltmeter and a number of storage cells the resistances were always lower, decreasing along an apparently hyperbolic curve, until with 100 to 125 volts the results obtained were usually between 1,000 and 2,000 ohms. . . . . That it (*i.e.*, the diminution of resistance with high voltage) is a peculiarity of living tissue, was shown by experiments with wet leather, meat and dead animals."

I do not wish to reopen a much-debated question, one which at best can receive only a modified answer, but if the writer of the above will refer to the second edition of my "Hydro-Electric Methods," published in 1896,† he will find some remarks which have a bearing on this subject. The following is one (p. 10):—"The only conclusion, therefore, to be arrived at is that the Wheatstone bridge method of measuring the resistance of an electrolytic circuit is misleading, since the resistance varies both with the current and impressed E.M.F., the magnitudes of which under ordinary conditions are unknown." This observation is made in connection with the question of ascertaining the R. of the hydro-electric bath, and is partly based upon the following curve formed from a series of results under different currents. It will be noticed that whilst the current varied from



0·83 m.a. to 87 m.a., the apparent total resistance fell from 876 to 88·4 ohms, or, roughly speaking, the current was increased from 1 to 100, and the R. fell from 100 to 10.

W. S. Hedley, M.D.

8, Mansfield Street, W.,
September 22nd, 1901.

Apprentice or Pupil.

It is with very much pleasure that I see in the "Correspondence" column in your excellent paper the controversy "Pupil or Apprentice." Perhaps my experience of ten years may be of value to some of your younger readers.

My parent paid a sum of 300 guineas to a certain engineer, who took me in hand as a pupil for three years to give me sound theoretical and practical knowledge of engineering.

When I left my pupilage I thought I required more workshop experience, so went as an improver, and from there I went to sea, and at last I have obtained an *extra* first-class Board of Trade certificate.

Now, with all this experience and study I cannot find employment, and am not better off than a fitter or ordinary engineer's workman. For four months I have struggled to obtain employment, and am no nearer obtaining it than I was four months ago.

From what I have said I maintain that it is at the least morally a criminality that such sums of money are taken from parents by the master engineers, knowing full well that it gives the young men for whom they are paid no more standing than if they were apprentice fitters or the like.

Perhaps these few words from one who has been "through the mill" may be a help to some young men.

Unus.

Working a Tesla Apparatus from Continuous Current, 220-Volt.

I have for the past five years used in X-ray work a Tesla apparatus and a step-up transformer supplied by an alternating current, 100 volts, 100 cycles per second. Now the supply is being changed to a continuous current at 220 volts. I like my apparatus and want to continue its use. How can I best supplement my present apparatus so as to use direct current? Of course, a uni-direction current will be better if I can have it.

T. M. C.

Newcastle-on-Tyne, *September 24th*, 1901.

The Iceland Cable Scheme.

I find that your Journal for August 30th contains a statement to the effect that the Great Northern Telegraph Company has decided to lay a cable to Iceland.

As no such decision has been taken, I should feel obliged

* ELECTRICAL REVIEW, July 25th.
† Lewis, Gower Street.

if you would mention in your next issue that the information given in the paragraph is without foundation, the scheme for the cable not yet having met with the support of the Governments of the large countries interested, which is necessary to supplement the assistance promised by the Danish and Swedish Governments.

F. C. C. Nielsen,
The Company's Representative in England.

London, E.C., *September 23rd*, 1901.

Coal Consumption in Power Stations.

With reference to your comments appearing in Electrical Review of the 20th inst. on the question of "Load Factor," I may state this was obtained in the following manner:—The total number of hours and minutes were taken during the time each set was running—say, for one week—and the kw.-hours calculated, assuming the machines to be generating normal full load for that period of time. This result divided by the units actually generated and recorded by meter for that same time and multiplied by 100 gives the "load factor."

H. E. Yerbury, A.M.I.E.E.

Sheffield, *September 24th*, 1901.

[There is an obvious slip of the pen in Mr. Yerbury's letter, as the units actually generated should be divided by the possible output in obtaining the load factor, not *vice versâ*, as given. The result is, of course, the "plant load factor" for the period considered—a very different thing from the station load factor; the former is of chief interest in this connection, although the latter is not without effect upon the coal consumption. Our correspondent's figures clearly indicated the immense superiority of a tramway load over a lighting load in this connection.—Eds. Elec. Rev.]

THE L.C.C. TRAMWAY ENGINE AND GENERATOR CONTRACTS.

Tenders have recently been invited by the London County Council for two 2,500-I.H.P. vertical steam engines, each coupled direct to a three-phase 1,500-kw. generator working at 6,500 volts between the conductors. The general conditions again stipulate that the contractors will pay to all workmen (apprentices excepted) "wages at rates not less and observe hours of labour not greater than the rates and hours set out in the Council's list," under certain penalties. The contractor is further bound to display upon the site of the works and in every factory or workshop used in the execution of the contract a copy of the schedule of the wages to be paid and the hours to be observed, and, whenever called upon, to produce his time and wages sheets to satisfy the Council that the schedule has been complied with.

We have frequently pointed out the objectionable features of these clauses, and have advised contractors to resist them as an undue interference in the management of their workshops. On this occasion, however, we wish to deal with them in their relation to foreign contractors. It is obvious that, so far as work executed abroad is concerned, the clauses are inoperative, as they would be applicable only to work executed on site, viz., erection and starting to work. In its desire, therefore, to conciliate the trades unions, the London County Council does its best to send work out of the country, as contractors at home are seriously handicapped by such objectionable conditions—conditions to which no self-respecting employer would submit, if not compelled to resist the inroads of foreign competition, which a section of our daily press in its misdirected zeal has done so much to promote.

Attached to this specification, however, there is another remarkable condition, which provides that "Tenders will only be considered for generators made by firms which have already manufactured three-phase generators of large size which have been in successful use for at least 12 months." Now we much doubt whether any British manufacturer had installed a large three-phase generator 12 months ago, and this is an argument whereof foreign manufacturers may be trusted to make full use. Apparently the advisers of the London County Council consider that experience in single-phase or two-phase machines does not form a satisfactory criterion of a contractor's ability to construct three-phase plant. There is no mystery, however, about the requirements of the latter, which are perfectly straightforward, and the construction of all types runs on identically the same lines. Assuming this point to be conceded, there is still a difficulty regarding size, as few of our home firms have in "successful use" generators which would comply with the London County Council's condition.

Of course, in comparing sizes, speeds must be taken into account, *e.g.*, a 500-kw. set of low speed may be found to be much larger than a 750-kw. high-speed set, or even larger than a 1,400-kw. high-speed set. It appears to us, therefore, that a much safer guide would be the actual inspection of generators made by tenderers, and of their facilities for constructing larger sets. There are several firms in England which have appliances equal to any in the world and are capable of turning out as large work.

We trust that the advisers of the London County Council will reconsider the conditions to which we have drawn attention, and give home manufacturers an equal chance with their foreign rivals. The former are no less qualified than formerly, the appliances and capital at their command are vastly enhanced, and the variety of types and applications of their products, although on a smaller scale than prevails abroad, is sufficient indication that they are capable of grappling work of any description, and of maintaining the manufacturing renown of the country.

REVIEWS.

Electrical Engineering Formulæ. By W. Geipel and M. H. Kilgour. London: The *Electrician* Printing and Publishing Company, Limited. 1901. New edition.

This handy pocket-book, we are told, has been thoroughly revised and brought up to date, while considerable additions have been made, especially in the section on electric traction. The first point about it which appeals to the practical user is its convenient shape, and the fact that it opens like a book; the index is fairly full, but a very brief trial shows that many of the things one wants are not indexed. These features—handiness and an extremely full and clear index—we regard as fundamental attributes to the ideal reference book.

Turning to the contents, we find that 542 pages out of 807 are occupied by general information on units, properties of materials, mathematical tables and formulæ, miscellaneous tables, buildings, boilers, heat engines, condensers, pipes, &c., and gearing; the remainder of the matter applies to dynamos, transformers, conductors, lamps, batteries, electric traction, mining, testing, and other essentially electrical subjects. To deal in detail with so great a mass of information would be too arduous a task, and we must confine our remarks to a few points only.

On p. 56 a table of resistances of metals is given in *legal* microhms; the word "legal" is misleading, as the "legal ohm," like the B.A. unit, is obsolete. But where does this table come from? We have not been able to verify it from authoritative sources.

On p. 62 the temperature coefficient of resistance of copper is given as ·00388 per degree Centigrade; this does not apply to the copper of to-day, for which the coefficient is known to be over ·004. The same criticism may be applied to several other values on this page.

There is a marked tendency to forget the fact that the work is intended (we presume) for busy men, and to insert matter of great scientific interest, but of no immediate use in electrical engineering. For example, we are informed that in the Young-Helmholtz theory there are in the eye three sets of nerves corresponding (or sensitive) to red, green, and violet lights respectively.

The theory of beams and struts is very fully treated, and an abundance of trigonometrical and other tables is

provided, as well as a brief outline of the differential and integral calculus.

In a very useful conversion table of English and metric measures the logarithms of the converting factors are given. In the building section there is a useful table of approximate prices for labour and materials. Water power and turbines are not forgotten, and formulæ are given for the flow of water in pipes. A very large amount of space is devoted to boilers, heat engines, &c.; standard specifications and formulæ are given for the construction of boilers, with rules for their management and testing. Gas and oil engines are dealt with before steam engines, and some rather ancient tests are given, but the largest engine referred to is of less than 200 H.P. Steam engines are treated at some length, with a considerable amount of text-book matter; useful information regarding condensers, pumps, pipes, &c., is included.

In the section on dynamos, a large number of time-honoured formulæ and data are found, which have done good service in the past, but are of little use in designing modern multipolar dynamos with slotted armature cores; indeed, we question whether the latter are so much as mentioned. In the same way, the section on alternators (comprised within four pages) is of little practical use. Under the heading "Continuous Current Motors" there is some confusion; we are told (p. 573) that if the field connections (of a series dynamo) be reversed, "the machine will run as a motor *or dynamo* in the same direction." Again, "a shunt machine as motor or dynamo runs in the same direction *if the P.D. at its terminals is the same.*" The italics are ours, and the parts italicised are clearly misleading. On p. 575 it is stated that if a shunt motor *gains* speed as it is loaded up, the motor may be compounded to run at a constant speed by the addition of a series coil connected so as to assist the shunt winding. We have heard of this remarkable shunt motor before, which runs faster as the load is increased; but we have never come across one, and we are satisfied by theory and experiment that it is a myth. An article on transformers is contributed by Dr. Sumpner, and a table of tests of some very small transformers is given.

The design of feeders and mains to give the best results, a subject upon which one of the authors has written an excellent treatise, is dealt with fully; but we fear that, save in the case of long transmission lines, few engineers as yet set about this work on the lines marked out by theory.

Useful information is given under the heading of "Arc Lamps," though some errors occur; for instance, hissing is said to be due to too short an arc, and iron wire is objected to as a steadying resistance because of its high temperature coefficient—whereas this is really an advantage. We fail to see the use of a classification table of the various methods of regulating arc lamps.

The section on primary cells is commendably brief. Electric traction is dealt with at considerable length, mainly in a descriptive manner; however, a large number of data are given which will be of practical value. The same criticism applies to the section on mining.

The testing section is very disappointing; it is practically confined to a few laboratory tests, and nothing is said about the every-day tests required in ordinary engineering practice. A miscellaneous collection of tables, fire risk rules, &c., concludes the volume.

While, as we have said, there is far too much text-book matter in the work—which ill accords with the title—it undoubtedly contains an immense mass of information of value to the electrical engineer; the large space devoted to mechanical engineering, which forms so large a proportion of the duties of that "Admirable Crichton," the central station engineer of to-day, ought especially to render its popularity beyond question.

The Late Lord Armstrong.—In order to perpetuate the memory of the late Lord Armstrong and his sterling services to the people of his native city, there is a movement on foot under the patronage of Earl Grey, the Duke of Northumberland, and others, to erect a statue in some public place at Newcastle, and to complete the building of the College of Science,

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 25th, 1900.		Week ending Sept. 24th, 1901.	
Adelaide	Value £136	Adelaide	Value £76
Amsterdam	155	„ Teleg. cable	2,400
Bergen. Cable	14,910	„ Teleg. mat.	139
Bombay	58	Alexandria. Teleg. mat.	1,007
Brussels	36	Amsterdam	57
Buenos Ayres	27	Bangkok	86
Calcutta	115	Beira. Teleg. mat.	85
„ Teleg. wire	126	„ Teleph. mat.	103
Cape Town	55	Bombay. Teleg. mat.	50
Chili	200	Brisbane	115
Colombo	20	Buenos Ayres. Teleg. mat.	150
Copenhagen. Teleg. wire	271	Calcutta	906
Durban	221	Canaries. Teleg. cable	10,140
Fremantle	255	Cape Town	616
Hamburg	110	„ Teleg. mat.	439
„ Teleg. mat.	500	„ Telephones	124
Hong Kong. Teleg. mat.	202	Chinde	23
Kobe	296	Copenhagen. Teleg. wire	39
Lisbon	45	Durban	22
Madras	159	East London	84
Melbourne	286	„ Teleg. mat.	219
New York	300	Fremantle	60
Ostend	344	Hobart	59
Otago	78	Hong Kong	27
Port Elizabeth	25	Madras. Tramway cable	759
Rotterdam. Teleg. wire	17	Melbourne	50
Singapore	40	Otago	1,225
Stockholm. Teleg. cable	283	Perth	457
Sydney	545	Port Elizabeth	870
Toronto	20	St. Michael's. Teleg. mat.	24
Wellington	24	St. Petersburg	81
		Shanghai. Teleg. wire	29
		Singapore	110
		„ Teleg. wire	12
		Stockholm	460
		„ Teleg. wire	110
		Sydney	493
		„ Teleg. mat.	107
		Tokio	243
		Valparaiso	60
		Yokohama	321
Total	£19,859	Total	£21,884

Foreign Goods Transhipped.

Gothenburg. Elec. apprts. Value	£103
Sydney. Elec. mat.	258
Total	£361

Acetylene Lighting in Spain.—A company has just been formed in Barcelona with the title La Compania General de Alumbrado por Acetileno, to establish acetylene lighting plants on the Ponres system in various parts of Spain.

Enclosed A.C. Arc Lamp.—A new lamp, known as the "Angold," which is being placed upon the market by the General Electric Company (1900), Limited, is described in an advance sheet of their arc lamp catalogue. This lamp is intended for A.C. circuits of any frequency between 40 and 100 cycles per second; it is provided with a weather-proof cover, and is self-contained with its choking coil, &c. The length over all is 24 in. The lamp burns 70—80 hours with 13 mm. cored carbons, and it is claimed that the efficiency is very high.

Glasgow Tramway Telephones.—We are informed that the system of telephones in street pillars, of which we gave an illustration in our last issue, is, strictly speaking, not part of the "traction" telephone system introduced by the General Electric Company (1900), Limited. The latter is, however, in use in Glasgow. One of its chief features is the fact that the plug boxes are placed in the feeder pillars, *not* in special pillars as we implied.

The Glasgow Exhibition.—Representatives and attendants in the machinery section are to hold a concert, supper, and dance on October 18th. Mr. Thomas Young, the engineer and electrician of the Exhibition, is to preside.

Electric Light Fittings.—Messrs. Hampton & Sons, Limited, the well-known West-End house furnishers, of Pall Mall East, have established an electric light fittings department, where they make a special feature of artistic work in the illumination of private residences, country houses, and the like. A couple of dark rooms have been specially constructed and beautifully fitted up, so that the illuminating effect of any electric fitting may be observed by customers by day or night, and they may obtain any fitting they care for in keeping with their purchases in the furnishing department of the same firm. The electrical affairs are under the management of Mr. H. J. Moore, and original schemes for decorative domestic lighting are drawn up from time to time. The catalogue contains various designs of electric fittings sandwiched between gas fittings, cutlery and furnishing ironmongery for general convenience, but we understand that a special electrical catalogue is shortly to make its appearance. There is a considerable demand at present for oxidised silver work. We give a few selected illustrations of some neat things, which will show what is being supplied. Fig. 1 represents a lacquered gilt Louis XV. lantern with richly cut glass globe; fig. 2 is a polished

Fig. 1.

brass 2-light fitting; fig. 3 shows a lacquered gilt Louis XIV. lantern; fig. 4 a one-light fitting in lacquered gilt (Louis XVI.)

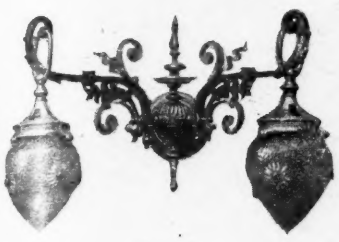


Fig. 2.

Fig. 3.

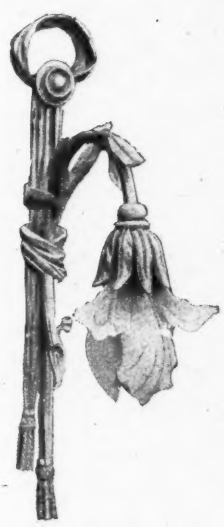


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

with iris shade and holder; fig. 5 is a polished brass lantern fitting with opalescent cylinder; fig. 6 illustrates a bronze figure "La Plage;" and fig. 7 a similar figure, "La Vague."

Electric Organ Building.—An electric organ has recently been completed at the Battersea (S.W.) Town Hall by Messrs. Norman & Beard, Limited, of Organ Works, Norwich, and Queen Victoria Street, E.C. The organ is divided and placed on both sides of the platform. A similar organ has also been completed by the same firm at Kirkcaldy Town Hall, but it is divided into three portions and bracketted from the walls above the platform, no floor space whatever being occupied. The movable console or keydesk stands on the floor of the hall below the platform. The action is electro-pneumatic throughout, the connection between the keys and the speaking portion of the organ being made by means of electric wires instead of by purely mechanical means as is the case with instruments of ordinary type. The keyboards are connected with the sound-boards on which the pipes stand, by a cable consisting of more than 1,000 wires. By pressing down a key an electric contact is made, causing a pneumatic motor in the wind chest to open, admitting wind to the pipe and allowing it to speak. When the hall was designed no provision was made for the placing of an organ, but the difficulty has been solved by the expedient of dividing it into three portions, as mentioned. The "touch" of the keys is so light and instantaneous that the most rapid passages are easy, and the keyboards are also provided with what is known as "double touch," thus enabling the organist by deeper impression of the key to give expression to individual parts. Instead of the old-fashioned rows of stops on each side of the player, the different sets of pipes are controlled by a row of ivory levers placed above the upper manual, where they can be more easily manipulated, and, besides this, there is an elaborate system of accessory movements which renders any combination of stops that may be desired easily obtainable. The organ at Kirkcaldy was presented to the town by Mr. Andrew Carnegie, at a cost of over £3,000. Messrs. Norman and Beard are also just about to commence the construction of an organ on precisely similar lines for the Dover Town Hall, and in this case the instrument is presented to the Corporation by Dr. Astley, a former Mayor of the town, at a cost of £3,000. They also last year placed in the Victoria Rooms, Clifton, Bristol, an electric organ, which is placed on a gallery at one end of the hall, the console standing on the floor below. Recently they put up an electric organ in the Earl of Leicester's private chapel at Holkham Hall, Norfolk. In this case, the chapel being small and no floor space available, the instrument is divided into two portions and bracketted from the wall of the chapel, the movable console or keydesk being placed in the chancel. Among other important electric organs which they have built may be mentioned those at Llandaff Cathedral, Haileybury College Chapel, the Parish Church, Burton-on-Trent, the Parish Church, Sutton Coldfield. All these instruments are interesting as examples of what can be done by electricity when no accommodation has been provided for an organ of the ordinary type.

B.T.H. Removing to Rugby.—The British Thomson-Houston Company, Limited, electrical engineers and contractors, will shortly remove the majority of their staff from their present offices, 83, Cannon Street, and 26 and 27, Bush Lane, to their works at Rugby, which will in future be the head office, only a branch office being retained in London at 83, Cannon Street.

Trade Announcements.—Messrs. Körting & Mathiesen wish to inform the trade that they have, by mutual agreement with Mr. Braulik, transferred the sole right to sell their arc lamps and accessories for Great Britain, Ireland, and the Colonies to the Union Electric Company, Limited, of 151, Queen Victoria Street, London, E.C., where an adequate stock will be kept in order to ensure prompt delivery. The Union Company have forwarded to us a copy of their new catalogue of these lamps, the demand for which is such that the factories have been extended so that they are able to turn out upwards of 40,000 complete arc lamps per annum. The list is neatly bound in stiff covers, and details and illustrates many types of lamps, both open and enclosed, and for public and factory lighting.

Mr. T. Harding Churton, of Leeds, has removed his works from Great Wilson Street to more extensive premises in Ingram Street known as Atlas Works. The new premises have undergone considerable alterations, and are now well adapted to the manufacture of electrical machinery. The step was rendered necessary in order to cope with the increasing demand for the electric generators, motors, and accessory appliances, of which Mr. Churton has made a speciality. The standard machines, with the exception of the largest sizes, are made in quantities and stocked for prompt delivery. These include generators for direct coupling, belt, or rope driving, motors of various kinds, especially enclosed or protected type furnished with speed reducing gear, also to a motor of which a number are being supplied for coal-cutting machinery. The manufacture of polyphase motors is also receiving careful attention, and important experiments are being conducted. In addition to many home orders, Mr. Churton has in hand a number of machines for India and the Colonies. Messrs. Fuller, Macleod & Co., Limited, of 9, Red Lion Court, Cannon Street, E.C., have taken over the London branch of the business, and will attend to inquiries.

The Crystal Electric Lamp and Rose & Bird, Limited, of Bedford, have altered the name of the company to Cryselco, Limited.

On September 29th the business hitherto carried on by the Park Foundry Company, Limited, at Ashforth Street, Nottingham, will be transferred to new and more commodious premises at Belper, near Derby. Communications should be addressed to "Engineering and Machine Tool Department."

Electrical Illumination in France.—The following further particulars are furnished to us as to the extent of the work done on the E.L.B. system through the company's French agents and contractors, in the very short time available. The whole of the official electrical illuminations at Compiègne were done on this system, the illumination devices alone carrying 12,000 lamps, whilst no less than 500 garlands of lights were also provided, and, further, 3,000 yards of illuminated festoons. The whole of the official electrical illuminations on the Prefecture buildings and the Town Hall at Dunkirk were done on the E.L.B. system, the illuminating devices alone carrying 3,000 lamps. The trans-Atlantic liner, *La Gascogne*, was also lit up, as well as one of the cruisers of the French fleet, the latter as an experiment for future illumination of the French men-of-war. At Paris innumerable decorative schemes were carried out for business firms on the same system, but the most interesting was a design at the "Orangery" involving 4,000 lamps. The Electric Lighting Boards Company's agency at Paris was only opened in May last, but the various French electrical contractors and retail houses have already made extensive use of the system.

Street Lighting Fittings.—The use of glow lamps for street lighting has undergone considerable extension of late, and bids fair to become an important branch of the electric lighting industry. As greater attention is turned in this direction, so the variety of fittings and devices for the efficient application of elec-

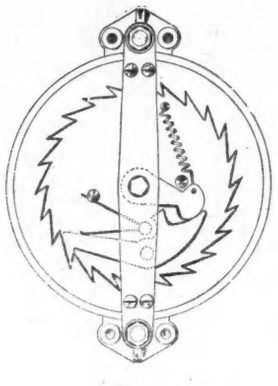


Fig. 1.

tricity for this purpose grows more complete, and the specialisation which is so marked a feature of modern industries makes its appearance. The Improved Electric Glow Lamp Company, Limited, in a well-executed brochure entitled "Street Lighting," places before the public a variety of systems in many of which its special type of lamp is made use of, as well as the necessary switches, fuse-

Fig. 2.

boxes and other accessories; the company also undertakes street lighting with arc lamps, both open and enclosed. Fig. 4 shows the fitting used at Ilford for converting ordinary gas standards and lanterns, arranged to clamp on the top of the post, and fitted with a two pole watertight fuse box. Fig. 3 is one of the neatest designs we have seen for a bracket fitting, and marks a radical departure from the conventional lantern necessitated by the use of gas; this type has been adopted at Rathmines. An ingenious safety winch for raising and lowering arc lamps is shown in fig. 1; it will readily be seen that the winch is always automatically locked unless the handle (which fits on the pentagonal end of the axle) is under control. Another very neat arrangement is used for supporting the

Fig. 3.

lamp in the hood independently of the suspension rope, yet without limiting the freedom of lowering or raising the lamp. A variety of designs for arc-lamp brackets is shown, of which probably fig. 2 is the most elegant. We note, too, various forms of the Hammond

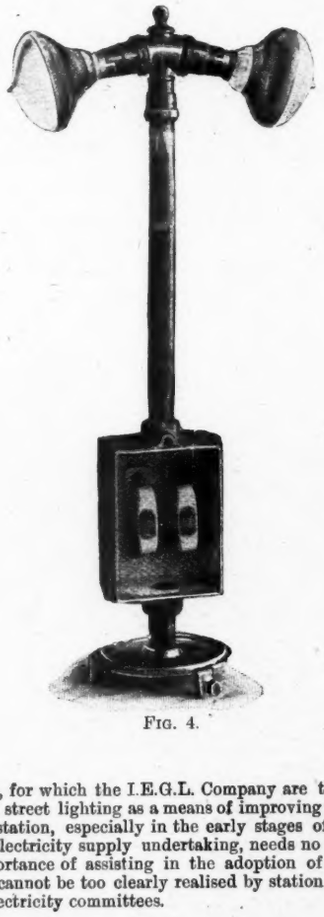


Fig. 4.

junction box, for which the I.E.G.L. Company are the sole agents. The value of street lighting as a means of improving the load factor of a central station, especially in the early stages of the development of an electricity supply undertaking, needs no demonstration, and the importance of assisting in the adoption of electricity for this purpose cannot be too clearly realised by station engineers and municipal electricity committees.

Port Glasgow.—The T.C. has resolved that a refuse destructor on the Meldrum principle be provided for the burgh.

Bankruptcy Proceedings.—The public examination of William Rushworth Beckton, electrical and general engineer, 13, Brownlow Street, Holborn, took place last Tuesday at the London Bankruptcy Court before Mr. Registrar Linklater. The debtor has lodged accounts showing total liabilities, £1,159 9s. 10d., of which £997 1s. 6d. is expected to rank against net assets valued at £375 14s. He stated in the course of the examination, which was conducted by Mr. E. L. Hough, senior official receiver, that prior to September, 1898, he was employed as an electrical engineer, but then, with a capital of £860, he commenced business on his own account at Brownlow Street as an electrical and general engineer. He attributed his insolvency mainly to loss in trading owing to heavy trade expenses, to bad debts and law costs, to the cost of alterations and repairs which he agreed to execute on obtaining a lease of his business premises, and to depreciation in the value of his stock and plant as now estimated for realisation. The examination was concluded.

A receiving order has been made, on his own petition, against J. A. Melville Collier, electrical engineer, Gateshead.

Dissolutions.—Messrs. F. A. Jackson and H. W. Ellis (Ellis & Ward, electrical engineers, Birmingham), have dissolved partnership. Mr. Ellis will continue the business under the old style, and will attend to debts.

Messrs. J. W. and J. S. Smith (J. W. Smith, electrical engineer, Nottingham) have dissolved partnership. Mr. J. W. Smith attends to debts.

Books Received.—"The Calorific Power of Fuels," by Herman Poole. New York: John Wiley & Sons; London: Chapman and Hall, Limited, 1901.

"Steam Boiler Practice," by Walter B. Snow. New York: John Wiley & Sons; London: Chapman & Hall, Limited, 1901.

"Steam Boiler Economy," by Wm. Kent. New York: John Wiley & Sons; London: Chapman & Hall, Limited, 1901.

"Gas and Fuel Analysis for Engineers," by Augustus H. Hill. New York: John Wiley & Sons; London: Chapman & Hall, Limited, 1901.

"Elektrische Kraftubertragung und Kraftverteilung of the Allgemeine Elektricitäts Gesellschaft, of Berlin," by Conrad Arldt. Berlin: Julius Springer, 1901.

"Science Abstracts" for September. London: E. & F. N. Spon, Limited, 1901. 2s.

Catalogues.—The General Electric Company (1900), Limited, have issued a new catalogue (Section O) dealing with their electro-medical apparatus, automobile accessories, &c. Several pages particularise induction coils, which are manufactured at the G.E.C. Manchester works. We also note the graphite rheostat, and some of the latest designs in electrodes. On a later page we observe complete battery equipments and the Faradic transformer, the latter being a special G.E.C. feature. The "Edison-Lalande" battery is a type of cell whose qualities might perhaps be better appreciated by those requiring a steady current and a low internal resistance. Some cheap reliable galvanometers and a line of pocket accumulators are also detailed, as well as automobile accessories which have been introduced to meet a growing demand.

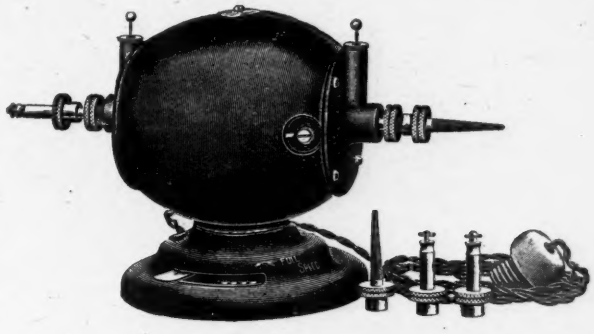
The "Desrumaux" Water Softening Company, of London and Bradford, have sent us one of their circulars describing their automatic water softener and purifier for use in connection with steam raising and other plants. We understand that the company has recently secured the following contracts:—South Hotton Colliery Company, Limited, Sunderland, 120,000 gallons in 12 hours; Southport Corporation, for their electrical power house, 96,000 gallons in 12 hours; E. Ripley & Sons, Limited, Bradford Dyers' Association, 77,000 gallons in 12 hours; John Cheetham & Sons, Limited, silk spinners, Brighouse, 17,600 gallons in 12 hours; Brighton and Sussex Steam Laundry Company, Brighton, 11,000 gallons in 12 hours. This company is also now erecting for the North Eastern Railway Company, at Hessle, near Hull, a large Desrumaux apparatus capable of treating over a million gallons per day for drinking purposes as well as for steam raising, and are also erecting at Warsop Junction an installation for the Lancashire, Derbyshire and East Coast Railway.

Since we referred a few weeks ago to a batch of new lists which had been brought out by Messrs. F. Suter & Co., the firm have issued several others describing their "Helios" specialties, copies of which are now before us. These are No. IV*a*, enclosed dynamos and motors (type H); No. IV*c*, two-pole dynamos and motors (type G); No. IV*d*, multipolar dynamos and motors (type MPD). The lists are all well laid out, with data in tabulated form and well-executed illustrations.

The Knecht Bros. Co., of Cincinnati, send us a small list of their Knecht friction sensitive drill press.

Outing.—The employés of the B.T.H. Company, now engaged on the construction of the Corporation electric tramways at Croydon, had an outing at Boxhill and Dorking last Saturday week, after their recent heavy work in connection with the completion of the base line of this undertaking, running from Norbury to Parley. At a dinner which took place in the evening at the Old Wheatsheaf Hotel, Dorking, a suitable present was made to Mr. A. G. Livesay, who is leaving the company to take up a position as an additional engineer on the Corporation tramway system of Leeds. The presentation, which was made by Mr. Fredk. S. Grogan, who has succeeded Mr. Livesay as resident engineer of the company at Croydon, consisted of a handsome silver non-magnetic stop-watch, supplied by Messrs. Smith & Son.

Dental Lathe Motor.—We illustrate below a new dental lathe motor (the Holtzer-Cabot) which is being supplied by the Stewart Electrical Syndicate, Limited, of New Compton Street, W.C. It embodies several improvements which experience has been shown to be necessary in motors of this class. The motor is of the enclosed type; the commutator, brushes, and all vital parts are thus protected, while the shell being oval in form does not obstruct the light nor interfere with the free movement of the hand while at work. The motor will develop a full ⅓ H.P. The speed can be regulated by rheostat in the base, so as to obtain 1,200, 1,800, 2,400 or 3,000 revolutions per minute. The armature can be instantly stopped, so that no time is lost in waiting for it to come to rest in changing from one polishing device to another. Five chucks are supplied with each motor, which are quickly attached by an accurate taper fit and run perfectly true; they are easily detached by means of a large jam nut, which will, when turned



force them off. The motors are wound for 110 or 220-volt direct current but, if desired, can be adapted to operate from storage batteries. The electrical design is such as to ensure high efficiency, which means a minimum cost in operating. The mechanical construction is substantial and accurate. The shaft is made of crucible steel and ground to gauge; ample bearings are provided, which are self-lubricating. It is stated that the machine will run even at the highest speed, practically without noise.

New Volt and Ammeters.—The accompanying illustration shows a new type of instrument which has been put upon the market by Messrs. Everett, Edgcumbe & Co. Ammeters and voltmeters of this type are said to possess several advantages over the ordinary commercial instruments; they can be employed indiscriminately for either alternating or direct currents without readjustment, whereas the ordinary voltmeter, for instance, calibrated for direct currents, will have an error of some 5 or 10 per cent. if used for alternating currents of frequency, say, 100. Hot wire

instruments have the same quality, but there are many cases in which these are not applicable, while it is claimed that the instruments under consideration are of really universal applicability. They are very dead-beat, and the whole of the working parts are mounted upon an insulating base, so that these instruments are well adapted for high voltages. Messrs. Everett, Edgcumbe & Co. so arrange the terminals in the base of the instrument, that while they are absolutely protected, connection can be made either from the front or the back of the board with equal ease, and without the use of cable sockets. It will be seen from the illustration that the instruments are of the enclosed type, and owing to their special construction, it is claimed that they are practically unaffected by external fields, such as those due to bus bar connections, &c. The case is enamelled black, with bright nickel lettering, rim, &c., and the instruments have a workmanlike and substantial appearance.

"Unbreakable" Pulleys.—The "Unbreakable" Pulley and Mill Gearing Company, Limited, of Manchester, are supplying a large number of their wrought-iron split pulleys for the Ordnance Factories of the Russian Government. Some idea of the magnitude of this department may be given by the fact that one item alone comprises 400 pulleys of exactly the same dimensions.

Technical Institute Notices.—The engineering and building construction classes at the Goldsmith's Institute, New Cross, S.E., opened for the winter session last Monday, 23rd inst. Mr. W. J. Lineham, M.I.C.E., is in charge of this department.

On Monday next, 30th inst., the twentieth session at the Polytechnic in Regent Street, W., opens. There are classes in chemistry, and special courses of instruction in electricity and magnetism, electrical engineering, telegraphy and telephony under the control of Mr. W. Hibbert, A.M.I.E.E., Messrs. Sewell and Thorrowgood, A.I.E.E's., and others.

Wolverhampton Exhibition.—Among exhibitors who have booked space at the Wolverhampton Art and Industrial Exhibition of 1902 may be mentioned the manufacturers of electrical machinery and appliances (amongst them being the Electric Construction Company, Limited) and builders of the most recent high-speed engines adapted for such purposes. Arrangements have also been made to show in actual work examples of the German water-tube boiler (Durr), and also the new Cahall water-tube boiler (largely used in the United States), the rights of manufacturing which have lately been acquired by boiler-making firms in England.

ELECTRIC LIGHT AND POWER NOTES.

Abertillery.—The D.C. has appointed a committee to consider a combined scheme for electricity supply and refuse destruction.

Bedford.—The E.L. Committee brought up a fresh list of applications for the post of chief electrical engineer, and a long discussion took place in the Council. Mr. C. Barkham, assistant engineer at Bedford, and Mr. R. W. L. Phillips, of Bristol, received strong support, but eventually the question was again referred back.

Brakpan.—The Rand Central Electric Works, Limited, received cable advice from Johannesburg that the works at Brakpan were expected to restart on the 23rd inst.

Brighton.—At last week's Council meeting a complaint was made regarding the number of engineers employed at large salaries in the electricity undertaking, and the suggestion was made that they should reduce the number of the staff and pay the men who did the work! A discussion arose as to whether the Council could discuss the question of salaries paid to the officials, and the Mayor ruled that they could not.

Epsom.—The R.D.C. has resolved that notice of objection be given to the Leatherhead and District Electricity Company, Limited, and to the B. of T., against the issue of a prov. order authorising the company to supply electricity throughout the rural district of Epsom.

The Council wants information as to the price and utility of penny-in-the-slot electric meters.

Darlington.—Last week Mr. W. O. E. Meade-King held a L.G.B. inquiry into the application of the Corporation for powers to borrow £12,250 for electric lighting purposes. The Corporation already provides power for 8,400 lamps of 8 C P. to 106 consumers, and by the end of the year it is estimated that power will be required for 18,000 lamps. The sum of £25,940 has been raised by loans.

Germany.—A central electricity generating station is about to be established at Bessigheim by Messrs. Brown, Boveri and Co., of Baden, Switzerland. Water-power is to be utilised, but a steam engine and boiler are to be kept in reserve. The plant will supply current for lighting purposes at Bessigheim, Freudenthal and Walheim, and for power purposes to a nail factory at Lochgau.

Glasgow.—The Electricity Committee recommends that an application be made to the Secretary for Scotland for sanction to borrow £250,000, in addition to the £900,000 for which his Lordship's sanction has already been obtained.

The accounts of the electricity department for the year show that after discharging all ordinary obligations, providing for interest on capital expenditure, and providing for the sinking fund, the accounts are just about square. Bailie Maclay, convener of the Electricity Committee, said that his Committee were of opinion that, taking into account the fact that last year was an exceptional year, that every article of consumption with them was advanced in price, and that they continued the price of the current at the old figure, they should be allowed to write off nothing for depreciation. In other days when they had a surplus, they wrote off very liberally for depreciation, so liberally, in fact, that when they spread it over the whole series of years since they began business it would amount to something like 4 per cent. per annum. During the last financial year the ordinary revenue from the sale of current advanced 66 per cent., the number of their consumers increased 41 per cent., and the motors connected at the end of the year were more than double those connected at the beginning. In their desire to meet the wants of the public they had been greatly reducing the price of the current. But for the advance in the price of coal last year they would have been able to write off for depreciation.

Grimsby.—The report of the electrical engineer shows that on September 10th there were 10,250 lamps connected and applied for, and probably the station will be fully loaded by March next year. Additional plant will then be necessary.

Heckmondwike.—The D.C. has instructed Mr. Hawtayne to prepare the necessary specifications for extensions of the electricity works which have been decided upon, so that the Council may be in a position to supply power to the British Electric Traction Company.

Ilkley.—The D.C. has bought the Ilkley electric lighting order from Mr. A. H. Gibbings, the promoter.

Italy.—The Allgemeine Electricitäts Gesellschaft, of Berlin, have just completed the establishment of a central electric power station in the Valley of Pompeii, near Naples. Water-power is utilised, the plant comprising three horizontal turbines of 150 H P. each and three large polyphase alternators. The current generated is transmitted for power purposes to the macaroni factories at Sorno Pompeii and Torre Anunziata.

Kilmarnock.—The T.C. has resolved to delay going on with the proposed electric lighting scheme.

Knaresborough.—The U.C. is considering the advisability of promoting a Bill which shall include powers for the provision of electric light and power, and the laying of tramways.

Lancaster.—Mr. Manville, in a report to the Electricity Committee, has approved of the plans and estimates of the electrical engineer (Mr. W. A. Tester), and recommends the Corporation to change the pressure of supply from 100 to 200 volts as previously suggested. The tramway scheme of the Corporation will ultimately cost over £70,000, but two lines about to be proceeded with are estimated to cost £23,000.

The Committee some time ago decided to charge a meter rent to all consumers of less than 30s. value of energy per annum. When the 12 months were up a charge of 13s. per meter was levied, and consumers to the number of 50 struck against it. They contended that they should not be charged more than the difference between their lighting bills and the 30s. The Committee saw the force of the argument, and has modified the charges accordingly.

Llandudno.—A report to the T.C. by the electrical engineer, Mr. Morton, respecting an extension of the electric lighting works showed that the extension of the plant contemplated in 1899, for which a load had been obtained, should be put in hand. The E.L. Committee recommended that the Council should instruct the electrical engineer and the surveyor to have the necessary plans and specifications prepared and have it carried out under the supervision of Mr. Morton, and that the question of remuneration, either by commission or increase of salary, be considered. This question of remunerating the electrical engineer for services in connection with the extension gave rise to a long discussion, owing to an arrangement being operative with Mr. Preece to act as consulting engineer until January next. It was thought that the new work should be regarded as an essential part of the electrical engineer's work. It was ultimately decided that the recommendation to grant Mr. Morton additional remuneration be not entertained.

London.—Fulham.—The B.C. has received a report from Mr. Medhurst with regard to proposed extensions of the electric lighting system; the engineer submitted estimates as follows:—

Boilers, flues, &c.	£3,680
Steam, exhaust and other pipes	900
Condensing plant	800
Engine-room plant	9,100
Sub-station equipment	1,400
Arc-lamp posts, &c.	5,723
Mains, conduits, &c.	23,357
Builders' work	900
Engineering expenses, &c.	3,680

Other electrical work brought up the total to £74,400. The Council decided, subject to the necessary estimates being submitted to the Finance Committee, to sanction the various extensions.

Stepney.—The B.C. is going to arbitration with reference to the County of London Company's claim for £21,000 as compensation for the loss of the district.

Battersea.—To-morrow evening practically the whole of Battersea will be illuminated by means of electricity, switched on by Mr. Torrance, chairman of the L.C.C. The whole of the work has been carried out by the Borough Council's own workmen at a cost of £152,000.

City.—According to the *City Press*, there is a reasonable prospect of some arrangement being arrived at between the Corporation and the City of London Electric Lighting Company. For months past the company has endeavoured to come to a satisfactory agreement regarding the contracts which were declared invalid, and in August last a definite offer was laid before the Corporation to the effect that the company would continue the public lighting in the western and central districts under the existing conditions, provided that the arrangements as to the lighting of all three districts be fixed until 1914, when the Corporation first has power to purchase. It is to be hoped that some such course will be adopted.

Manchester.—The Electricity Committee is seeking to add further to its powers for the construction and maintenance of a bridge, electric mains, wires and pipes near Dickinson Street and Bloom Street, and to acquire land near Stuart Street for the purposes of the electric undertaking.

Morecambe.—The D.C. is applying for borrowing powers for £2,000 for electricity supply extensions.

Nelson.—Last week an inquiry was held on behalf of the L.G.B. into an application by the Corporation to borrow £25,000 for electric lighting purposes. The electricity works will, it is stated, provide power for running a tramway and two light railways in the district.

Middlesbrough.—An inquiry was held last week by Mr. W. O. E. Meade-King, M.I.C.E., L.G.B. Inspector, into the application of the Corporation for leave to borrow £34,100 for electric lighting purposes. Powers had previously been granted for the borrowing of £36,000, and the present application was for extensions. The application was not opposed.

Oban.—The T.C. has re-appointed the E.L. Committee, with powers to proceed with the electric lighting scheme for which a prov. order has been obtained.

Portsmouth.—The T.C. has resolved to apply to the L.G.B. for sanction to borrow £23,000, the estimated cost of extensions of mains for the next three years.

Rothesay.—The T.C. is altogether dissatisfied with its electric light installation, but the consulting engineer reports that the contractors have carried out the work according to the specifications, and that the installation should be taken over and paid for. Proposals were made at a meeting of the T.C. recently that an independent engineer should be appointed to report on the matter, but it was pointed out that the engineer was *the sole arbiter in any dispute between the Council and the contractors*, and therefore an independent engineer could not be engaged. The position is interesting. We have inveighed against that pseudo-arbitration clause *ad nauseam*, but we had not anticipated the question being raised in this manner. We commend the case to the notice of all concerned in similar undertakings.

St. Helens.—On Sunday night, shortly after nine o'clock, an arc lamp in Church Street fell to the roadway, owing, it is said, to the breakage of the guard wires. The other arc lamps on the circuit were extinguished by the mishap. Traffic at the time was very brisk, but no one was injured.

Sheffield.—At a recent meeting of the Gas Company, Sir F. T. Mappin, M.P., the chairman, went out of his way to institute comparisons between the cost of gas and electricity for street lighting, which, to say the least, are highly misleading. For instance, the cost of incandescent gas lighting was said to be one-fifth or one-sixth of that of arc lighting. We defy anyone to prove this; on the contrary, light for light, the arc costs less than any other practical illuminating agent. The chairman went on to pick out places where the electric lighting undertaking had resulted in a loss to the authorities, asserting, for example, that at Liverpool the profit last year was £6,000 less than in the previous year. Apparently he forgot that he had just stated that his own company had been obliged to take £15,639 odd from the balance in hand in order to maintain its usual dividend. Are there no gas supply systems which have proved unprofitable? Sir Frederick even dragged in the statements of a defaulting electricity consumer as evidence that electricity costs more than gas! We have no desire to criticise the rival illuminant too severely, but we do like fair play.

Southport.—A new 1,000-H.P. engine for driving additional dynamos for lighting the town is now in course of erection. The demand for electric light has steadily increased; there are now nine boilers laid down, and with the new engine the plant will be altogether equal to 3,000 H.P. At present from 20 to 25 electric cars can be kept in motion at once, but the Committee purposes increasing these to 50, which will be necessary when the extensions of lines are made.

Spain.—A central station has just been completed and put in operation in the town of Alcoriza. Water-power is utilised.

Warrington.—A L.G.B. inquiry has been held at Warrington respecting the application by the Corporation for power to borrow £15,000 for electric lighting purposes. Powers have already been sanctioned to borrow £44,966, and nearly all of this sum has been raised and spent in the erection of electric plant and laying of mains. The Corporation have 72 customers for lighting energy, and are lighting streets outside of the compulsory area. Mr. Grimsdale, electrical engineer, stated at the inquiry, which was conducted by Mr. M. K. North, A.M.I.C.E., that in January last there were 546 8-C.P. lamps in the town, and that at present there were 10,910. In February next the new tramways would come into operation, when there would be a great increase in the demand for electricity.

Worksop.—The electric lighting installation was formally inaugurated on Thursday last week. Worksop is the first town outside the capital of the county to adopt electricity for purposes of public lighting and motive power in Notts. The generating station has been erected under the direction of Mr. A. B. Mountain, of Huddersfield, the consulting engineer. The buildings consist of a boiler house to accommodate four Lancashire boilers, of which two have been fixed at present; an engine room for two 100-KW. sets, and three of 150 KW. each, with the necessary condensing plant, pumps, boosters and switchboards. The plant at present fixed is sufficient to generate electricity for 11,600 lamps of 8-C.P., and there is also a battery of accumulators. At the formal opening ceremony the guests were received by Mr. J. T. Shardlow, J.P., chairman of the U.D.C., who was presented with a gold key to the works by Mr. Mountain. The cost of the works was £15,000, and 72 applications have been received for the supply of electrical energy equal to 2,000 lamps of 8-C.P., and three for motive power.

Worthing.—The Corporation electric lighting works were on Saturday opened by the Marquess of Abergavenny, the Lord Lieutenant of Sussex. Distributing mains have been laid in all the chief thoroughfares of the town, and there is a considerable demand for the new light, the applications from private consumers being equivalent to about 3,000 8-C.P. lamps. The street lighting has involved the erection of 110 arc lamps, each of 1,000 C.P., and on the sea front the standards are only 45 yards apart.

ELECTRIC TRACTION NOTES.

Batley.—The Corporation on Monday resolved to call upon the Dewsbury, Batley and Birstall Tramways Company to sell to the Corporation so much of their undertaking as is within the borough. The Corporation, who have obtained an order empowering them to construct electric tramways within the borough, will be able to purchase the existing system, on which steam is used, at a valuation, without paying anything for goodwill. When the undertaking is taken over by the Corporation, steam will be superseded by electricity.

Brighton.—The construction of the lines has been a good deal delayed on account of the insufficient supply of red gum wood paving blocks, as many as 25 per cent. having to be rejected as unsound. The Committee have authorised the contractors to obtain the blocks from other sources. The Westinghouse Company (the contractors for the cars) have now delivered about a dozen of the cars, and it is hoped to have a trial run in a few days' time. The opening day, which is not yet definitely settled, will take place in about a month.

Bristol.—The Bristol City Council, at a special meeting called for the purpose, discussed for two hours and a half a proposal that application be made to the Board of Trade to hold an inquiry into the accidents which have recently been associated with the running of the Bristol electric tramcars. The meeting was opened by a suggestion from Mr. Baster, a Socialist member, that if, as was reported, the Lord Mayor was a large shareholder in the tramway company, he should take no part in the proceedings. The Lord Mayor said he was a shareholder, but was not disqualified on that account from presiding, and he intended to conduct the proceedings. The meeting then proceeded, but ultimately when a vote was taken his Lordship did not take part in the division. The resolution in favour of the application to the Board of Trade was moved by Mr. Pope, a labour representative, in a speech dealing largely with bye-laws and official regulations for electric traction. On the other side the chief spokesman was Alderman Inskip, who argued that there was no necessity to approach the Board of Trade, who were already fully safeguarding the public interests. He moved, under these circumstances, that the question be not put. Any inclination on the part of the Council to adopt the amendment was lessened by the statement that in four weeks before the tramway dispute 10 accidents involved no personal injury, and in four weeks subsequent to the dispute 45 accidents resulted in 27 cases of personal injury. With these figures before them more speakers advocated inquiry than opposed that course, and Alderman Inskip withdrew his amendment and proposed another calling for a report on those accidents from the Watch Committee. This was carried by 28 votes to 27. This amendment for the time blocked further progress with the proposal to appeal to the Board of Trade.

Brussels.—We understand from M. Janssens, the director-general of the Brussels Tramways, that important developments of the system are in progress. At present numerous works are in course of construction, including the building of an additional new power station in the Rue de Birmingham, which will take the place of the old installations in the Rue Brogniez. The conversion of the lines at present worked by animal traction over to electrical working is being actively pursued. The company were allowed five years for the completion of the various works in hand, and which were commenced last year, but M. Janssens calculates that in all probability they will be finished during the spring of 1903. The new power station in the Rue de Birmingham will be bounded on one side by the canal and will be in touch with the railway. The engine room will be 100 metres long, and will be provided with plant of 8,000 H.P. total capacity in four large sets. Plenty of room will be available for later extensions, even to 30,000 H.P. The works at present in hand or in contemplation represent a matter of ten million francs, of which five millions will be spent on the power station alone.

Crewe.—On Monday the Earl of Jersey and Colonel Boughey held an inquiry at Crewe respecting the application by the B.E.T. Company for an order to construct light railways at Crewe and between Crewe and Haslington. For the promoters, Mr. Morse stated that the proposed railways covered over six miles, and the estimated cost was £73,000, or £12,000 per mile. It was proposed to work the cars on the overhead trolley system. Several witnesses having given evidence, Mr. Stephen Sellon, engineer to the promoters, described the proposed lines. Opposition was offered on behalf of the Town Council. After consultation the Commissioners decided that, in face of the unanimous feeling in the town, they could not force the scheme upon it. The application was accordingly refused.

Gillingham.—The D.C. and the Chatham Electric, &c., Tramway Company have again been in communication with each other relative to the laying of wood paving between the rails instead of granite headers as at present being used. A letter and telegram from the company stated that as the company had now

determined to place wood pavement between the rails in the High Street, and the difference in the cost of maintenance being "three to one," the company were prepared to pay as much as would be required to maintain the granite, the Council to pay the other two-thirds. A considerable discussion ensued, various opinions being given, and several councillors expressed disapproval of the work done by the company. Finally, a suggestion that the company should maintain the portions in question or that the matter should be referred to arbitration, was adopted, and the company's attention is to be called to the section in the Order which imposed these conditions. It was stated that at Chatham the company were going to maintain their portion of the wood paving.

Greenock.—The inspection of the reconstructed permanent way between Greenock, Port Glasgow and Gourock has been made by Lieut.-Colonel Von Donop, R.E., for the Board of Trade. The various burghs and companies interested were well represented. There is every likelihood of the new service commencing operations on October 1st.

Halifax.—A new section of the electric tramways was opened on Thursday last week. It is about a mile in length, and extends from the main line to Stump Cross, at New Bank Junction, to the Cock and Bottle Inn at Southonram, on the boundary of the borough. The last extension to be carried out for some time, namely, from Mytholmroyd to Hebden Bridge, is practically completed.

Ham (Surrey).—The U.D.C. has decided not to approve of the suggestion of the L.U.T. to connect Richmond and Kingston by means of about a mile of overhead trolley tramway through its district.

Isle of Man.—The liquidator of the Isle of Man Tramways and Electric Power Company, Limited (Mr. W. H. Walker), has intimated that he is not disposed to accept any of the tenders recently sent in for the purchase of the company's undertakings. If the Douglas Town Council increased their offer of £40,000 for the Douglas Bay horse section and the Upper Douglas cable section to £50,000, it is said that the liquidator would accept it. The cable section has been worked at a loss of about £2,000 a year, which will shortly be increased by a 5 per cent. royalty charge to the Douglas Town Council—to about £2,500. The horse section has been earning a net profit of about £6,000; this will, however, be reduced by a royalty charge of 15 per cent. on the gross earnings, to about £4,200. On the basis of recent returns, it is computed that a loss of about £850 a year would be incurred by the Corporation if £50,000 were paid by them for the two sections named.

It is stated that a fresh offer has been received by the liquidator from an English company to take over the Douglas tramways if the Corporation of Douglas will agree to the use of electricity on the Bay section. The company also offer to light the promenades free if their proposal is agreed to.

Keighley.—The Corporation has instructed the borough engineer to prepare estimates for the permanent way between Ingrow and Utley and overhead equipment for the same, and to prepare a scheme for new tramways in four other directions.

London—Brighton Project.—The daily papers have been giving a good deal of attention to a scheme for running an electric line between London and Brighton with perfect safety at 120 miles an hour, for 5s. and 3s. (first and third-class respectively) return. The length of line, according to surveys which have been made by Mr. F. H. Cheesewright, is 47 miles. A half-hourly service from early morning to half an hour after midnight is suggested. Multiple unit control for the trains, and two generating stations are among its features.

London.—Fulham.—The Borough Council has discussed the proposal to run electric trams from Putney Bridge, through Fulham and Hammersmith, to Harlesden. The L.C.C. asked whether the B.C. would consent to the scheme, and would contribute one-third of the cost—£30,867—of the necessary street widenings. An amendment to the effect that the cash should come from the capital account of the London County Council was lost. The Council decided to approve the scheme and contribute one-third of the cost of the street widenings.

Wandsworth.—The Wandsworth B.C. has just been informed by the clerk to the L.C.C. that the Highways Committee is very anxious that electric traction should be applied to the tramcars running from Clapham Common to Tooting at the earliest possible moment, and that the work will be commenced immediately after the re-assembling of the Council. Once the work is commenced it will be pushed forward as rapidly as possible until completion.

Manchester.—The Tramways Committee is asking for power to construct several new lines of tramway in various streets of the city, and to authorise the Corporation to generate electrical energy on land belonging to this Committee at Queen's Road, Cheatham, and Hyde Road, Ardwick.

North Country.—The British Electric Traction Company are not allowing their scheme for a system of tramways from South Shields to Sunderland to rest dormant, and on October 1st the Board of Trade will hold an inquiry at South Shields into that company's application. The scheme is being opposed by both the South Shields and the Sunderland Corporations. The former have running powers over a portion of the route proposed to be followed by the company, but they have never exercised their power. The opposition of Sunderland is principally to protect their interests, as their trams run to the very boundary where the company's system will commence. It is interesting to note, however, that all the District and Parish Councils affected by the scheme are favourable to it. In connection with the British Electric Traction Company's scheme for a system of light railways running alongside the south bank of the River Tyne, another step has been taken. The company have already powers for the construction of it, and the company, the Durham County Council, and the South Shields Corporation have united for the construction of a bridge over the Don, a tributary of the Tyne, which was a necessary preliminary to the laying of the lines. The scheme of which this forms a part is a very large and comprehensive one, and the railway will reach from South Shields in the east to Ryton in the west, a distance of about 14 or 15 miles, and that through a very densely populated area.

Portsmouth.—The Corporation electric tramways were inaugurated on Tuesday afternoon. The acquisition of the old tramways, the introduction of electric traction, and the development of the system will involve a total expenditure of upwards of £600,000. With a fast increasing population, and the largest municipal system in the South of England, it is fully anticipated that a satisfactory revenue will be realised. A power station has been erected at Fratton, the order for which was placed with Mr. J. W. Perkins, of Southsea, whose tender amounted to £9,500. At three o'clock a number of the members of the Town Council and other local bodies, with a good sprinkling of the fair sex, including the Mayoress (Mrs. A. L. Emanuel) and the ex-Mayoress (Mrs. H. R. Pink) assembled in the power station, and the Mayor (Alderman A. L. Emanuel, J.P.) asked Mrs. Corke, wife of Councillor J. H. Corke, J.P. (vice-chairman of the Tramways Committee) to set the machinery in motion. This was speedily done amid the cheers of the company. The steam-raising plant comprises three boilers of the water-tube type. Three surface condensers have been provided, two of which are each capable of condensing, under ordinary working conditions, 12,000 lbs. of steam per hour, a smaller one being of a capacity sufficient to condense 6,000 lbs. of steam per hour. The cooling tower, which has been provided in conjunction with the plant, is in two sections, each of sufficient capacity for one large condenser. With an eye to probable requirements in a not distant future, provision is made for adding a third section to the cooling tower. The generating machinery is entirely of British origin and manufacture. It comprises low speed horizontal engines, direct coupled to tramway generators. The type of generator is that made by the English Electric Manufacturing Company, of Preston, and supplied by Messrs. Dick, Kerr & Co. The machinery having been started, the company were taken over the tramway line to North End, where they were transferred to eight gaily decorated electric cars. It had been arranged that Mrs. Kimber, wife of Councillor H. Kimber, J.P. (chairman of the Tramways Committee), should start the leading car, and before this was done, she was presented with a driver's license and gold-embossed badge. The line of route from North End to Clarence Pier, Southsea, over which the electric cars passed, was thickly studded with spectators. A run was next made back to the Town Hall, and the occupants of the cars took tea with the Mayoress in the *Maison de Ville*.

Mr. A. Rotter was appointed engineer and manager of the tramways in September, 1899, and was commissioned to draw up specifications and forms of tender; in the early autumn of last year contracts for the power-house plant, the permanent way and cables, as well as the cars, were entered into with Messrs. Dick, Kerr & Co., the overhead equipment contract being given to Messrs. Macartney, McElroy & Co. The power-house plant has cost about £30,000, the permanent way construction has involved an expenditure of over £200,000, and the cars have cost nearly £50,000. The system of traction is the overhead trolley; while the gradients are infrequent and by no means severe, the curves are numerous, and the radii in many cases fairly small, the sharpest curve having a radius of 35 ft. The total route length is approximately 14½ miles, there being 14 miles of double and interlacing track and half a mile of single. In a description of the works presented as a souvenir to each of the invited party it is stated:—"The construction of the permanent way has probably constituted a record for such class of work. Actual work should have commenced on February 11th, but for the first fortnight work was out of the question on account of severe frost. Up to the present time 23½ miles of track have been completed out of a total of 28½, which gives a rate of construction of a little less than a mile of completed track per week. The method of suspending the trolley wire embraces span wires and brackets, a considerable portion of the work being carried out with single arm bracket poles. The trolley wire is placed centrally over the track and is double throughout. The trolley wire is supplied in sections not exceeding half a mile."

On Tuesday evening the Mayor entertained a representative company at dinner in the banqueting room at the Town Hall. "Success to the Undertaking" was given by the Mayor, who expressed his belief that it had a successful future in store for it. Councillor H. Kimber, chairman of the Tramways Committee, responded. Toasts in honour of the two principal contractors were also proposed and suitably responded to.

Spen Valley.—The Cleckheaton District Council has approved the plans of the British Electric Traction Company for the Cleckheaton section of the Spen Valley line.

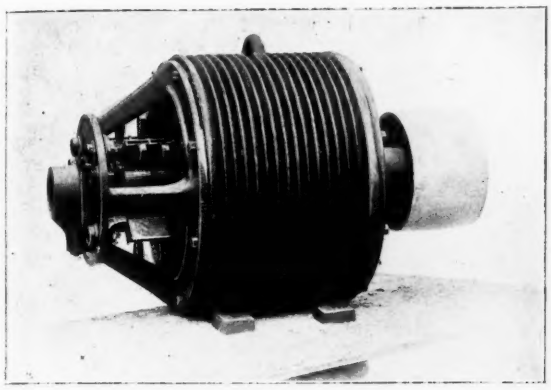
(*Continued on page* 519.)

GLASGOW INTERNATIONAL EXHIBITION, 1901.

XI.

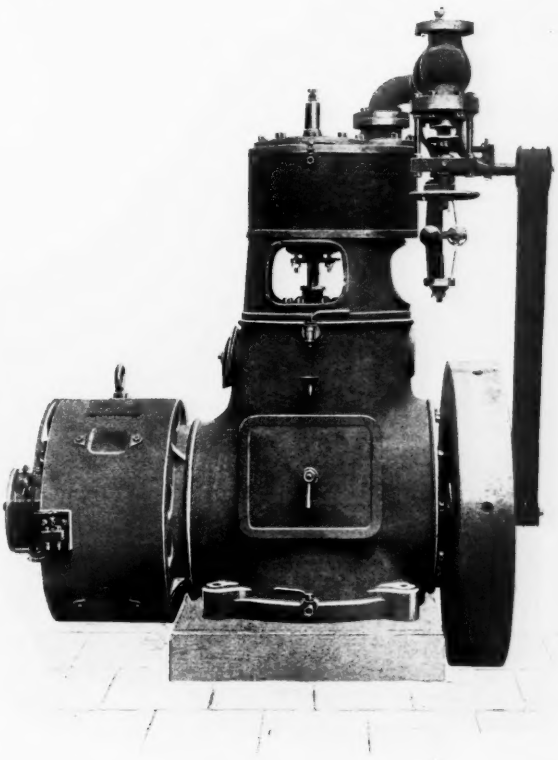
Messrs. Mather and Platt, Limited.

One of the largest and most comprehensive exhibits is that which has been organised by Messrs. Mather & Platt, Limited, of Salford Iron Works. The subjects chosen for



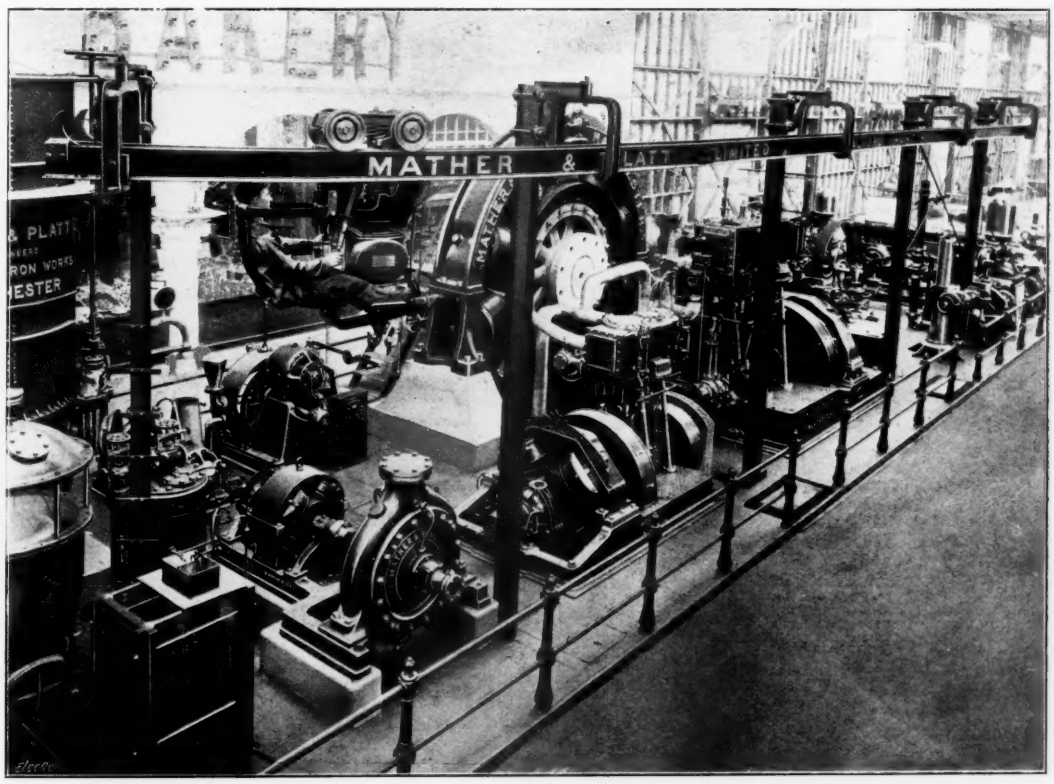
Semi-Enclosed Motor.

illustration from the company's wide field of enterprise, range rom the bleaching and washing of cotton goods to the iltration and purification of water, and from bacteria beds o steam dynamos and fire extinguishers. We must content urselves, however, with a description of the features likely o be of special interest to our readers. The part of the tand shown in our general view is devoted mainly to steam nd electrical appliances, of which the most prominent is one of the eight large generators destined for the Salford Corporation electricity works. We give a separate view of one of these, coupled to a Browett-Lindley engine. The output of the set is 775 kw., at 100 revolutions per minute. The armature weighs 25 tons, and the whole machine over 50 tons.



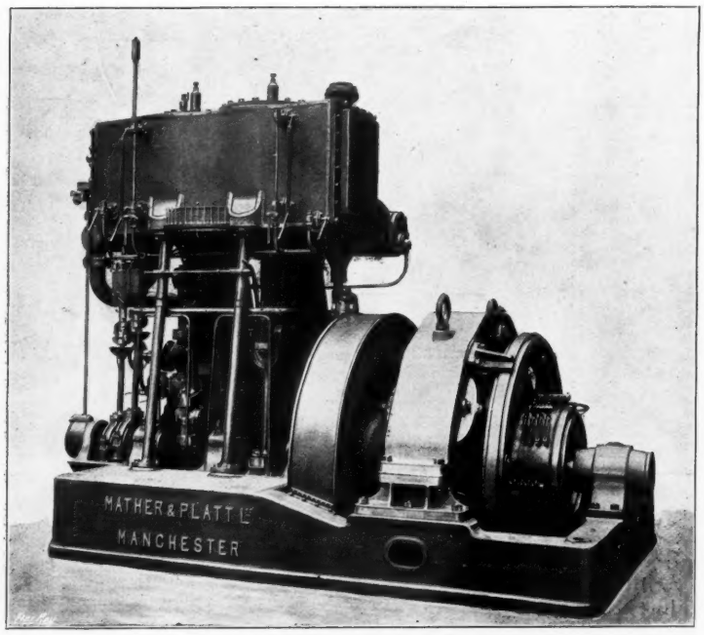
Single-acting Engine and Overhung Dynamo.

When used for traction the machines are compounded, working at a pressure of 525 volts; as shunt machines for lighting, they give the same output at 480 volts. They are capable of standing an overload of 25 per cent. in either case for half an hour. The efficiency at full load is said to be



Part of Messrs. Mather & Platt's Exhibit.

over 95 per cent., as the result of actual tests. The armature is drum wound, with slotted core, and the field magnet, which is made of cast-steel, carries 10 poles bolted to the yoke. The armature is 8 ft. 6 in. in diameter, and the shaft is 15 in. in diameter, with journals 14 in. diameter. The



135-kw. Steam Dynamo.

brushes are stationary from no load to 25 per cent. overload without sparking.

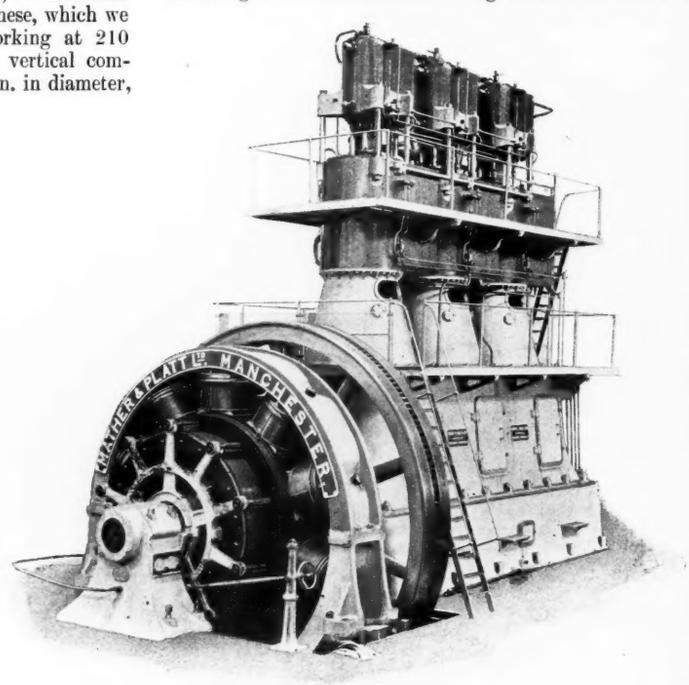
Two complete steam dynamos are shown, of 135 and 70 kw. output respectively. The larger of these, which we illustrate, consists of a multipolar dynamo, working at 210 volts, coupled to a 250-h.p. open type vertical compound engine. The cylinders are 14 and 24 in. in diameter, with a stroke of 16 in.; the high pressure cylinder is provided with Meyer expansion gear, variable by hand while the engine is running. The governor acts on a throttle valve, maintaining the speed constant at 180 or 190 revolutions per minute. The generator has a six-pole field, with aluminium spools. The yoke and poles are of steel, with solid pole shoes bolted on. The armature core is built up of steel discs, with ventilating spaces. The brush gear is neatly designed and very accessible, and the bearings are spherical seated, with ring lubrication.

The smaller set runs at 230 revolutions per minute, and is fitted with Messrs. Mather & Platt's crankshaft governor, which acts directly on a balanced piston valve on the high pressure cylinder; it is stated that trials of this governor show a temporary variation of 3 per cent. from no load to full load, and a permanent fall of less than 1½ per cent. This machine is used for supplying power to the stand.

A small steam dynamo, of 23 kw. output, is shown, in which, as may be seen from our illustration, the dynamo is bolted direct to the frame of the engine, forming a very solid and compact combination. The outer bearing is carried on the magnet frame. The engine is of the simple vertical single-acting type, the cylinder being 17 in. in diameter, with a stroke of 7 in. The set runs at 450 revolutions per minute at 200 volts. A single-acting compound engine is also shown, carrying in a similar way a centrifugal pump.

A highly interesting exhibit is a three-throw feed-water pump driven by an electro-motor. The rams are arranged radially round a shaft running at 100 revolutions per minute; the motor runs at a speed of 550 revolutions per minute, and is of the open type, having an output of 7½ b.h.p. when supplied at 200 volts. The special feature of this pump is the fact that it is arranged so that the throw of the rams can be varied from 4½ in. to zero, the maximum output being 2,500 gallons per hour against a pressure of 180 lbs. per sq. in. By means of a calibrated weir, the delivery can be gauged under different conditions, the pump being shown in operation; the delivery pressure can also be varied for the purpose of demonstration. The plungers are driven from a crank-pin by connecting rods; the crank-pin is fixed eccentrically on a disc fitting into a recess in a toothed wheel, which engages with a pinion on the motor shaft. The rotation of this disc, to vary the length of stroke, is effected by means of gears in the hub of the wheel.

The stroke is varied automatically by power to the desired value, which is adjusted by means of a regulator; this is provided with an indicator showing the length of stroke. The regulator is only in action while the stroke is being changed, so that the wear is small; and a failure of the regulating gear would merely mean the loss of the power of adjustment, as the running of the pump in no way depends upon it. The advantages of such a method of regulation over shunt and series rheostats, and series-parallel devices, which are commonly used for adjusting the delivery of electrically-driven feed pumps, are self-evident.



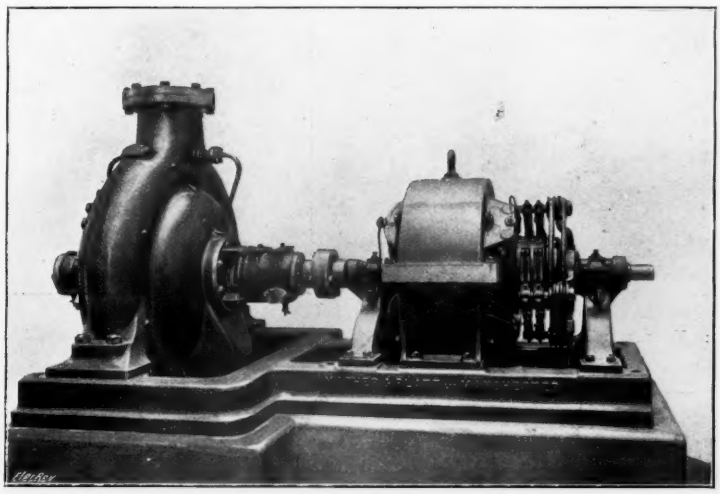
Mather & Platt 775-kw. Dynamo and Browett-Lindley Engine.

The valve boxes are arranged so as to be removable, and the valves are readily accessible.

A large high lift centrifugal pump, driven by an electric-

motor, forms one of the exhibits; this is capable of delivering 1,250 gallons per minute against a head of 95 ft., at a speed of 700 revolutions per minute. The pump is of the single-chamber type; the water enters the revolving wheel axially, traverses the curved passages therein, and is discharged into guide passages leading into a whirlpool chamber. The motor is mounted on the same bedplate, and is of the open type, of 50 B.H.P., with a four-pole field. The combined efficiency of the set is said to be 62 per cent. One of our views shows the pump and motor complete.

A somewhat similar set, with a delivery of 210 gallons per minute against a head of 70 ft., at 1,400 revolutions per minute, is shown working. The motor has an output of 13 B.H.P. at 200 volts, and is semi-enclosed, with four poles.



High Lift Centrifugal Pump.

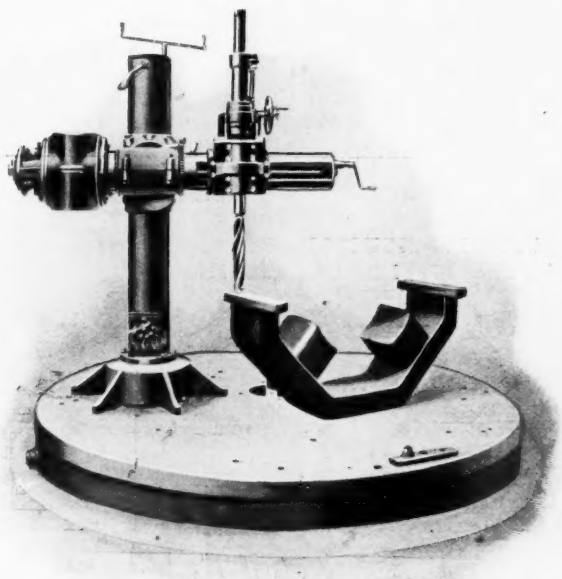
Special attention has been paid by the company to the design of these centrifugal pumps, especially for high lifts; they are made with several chambers in series, where extreme heights are to be overcome, the height of delivery being proportional to the number of chambers. The rotor is designed with a view to obtaining the highest efficiency, and is made of gun-metal; the fixed blades are of cast-steel, and the body of the pump of cast-iron. There is a water seal on the shaft, and the wheel is balanced, suction being taken from both sides.

A series of motors of various types forms part of the exhibit. These are mostly four-polar, and steel-clad. Where the motor is wholly enclosed the shell is ribbed, so as to give as large a radiating surface as possible. Examples are shown ranging from 4 to 40 H.P. The one which we illustrate is of 4 B.H.P., running at 1,400 revolutions per minute. These motors are made with interchangeable parts, to stock. It is interesting to note that Messrs. Mather & Platt are using the metric system in their shops, and have met with no difficulty in its introduction.

Various motor-driven pumps and other machinery are shown, in addition to those already mentioned. We illustrate a handy electrical drill, which was described in the Electrical Review some months ago. The spindle is geared by spiral gear with a ratio of 9 to 1 to the motor shaft, and is carried in such a way that holes can be drilled in any direction whatever; as the parts are balanced, it is easily adjusted to the desired position, and the drill is provided with a magnetic holding-down device and a power feed. The drill can be used for holes up to 2½ in. diameter, within a radius of 42 in.

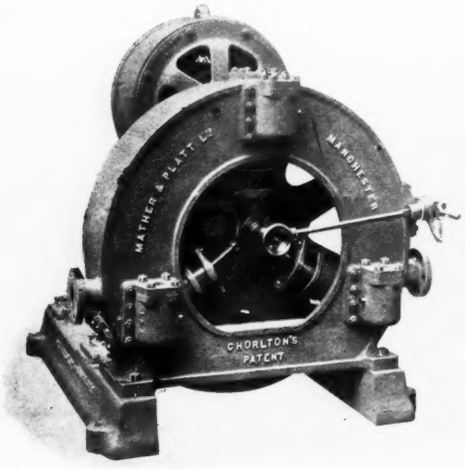
An electrical conveyor forms the subject of another figure; this is especially intended for railway stations, for the conveyance of parcels from one platform to another. The two rails form the lead and return, and the traveller is provided with both lifting and travelling gear, which are under ready control. A similar apparatus has been adopted in one of the London electricity works for carrying coal from carts to the storage bunkers; the operator can pick up a full skip, weighing 16 cwt., convey it to the bunkers 120 yards away, and return before a second skip is filled. The apparatus has also been installed at the Victoria Station, Manchester, and at York station.

Electrical Conveyor.

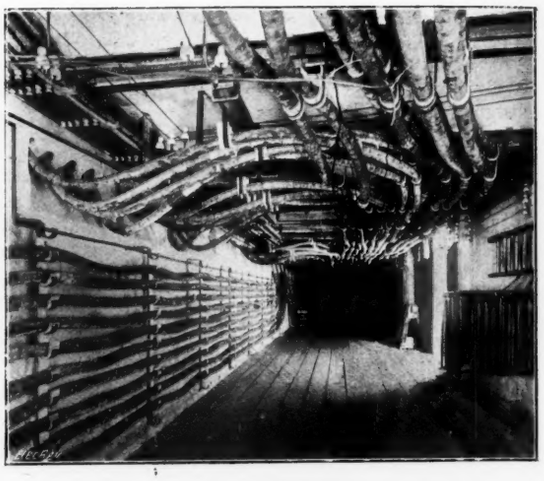


Portable Electric Drill.

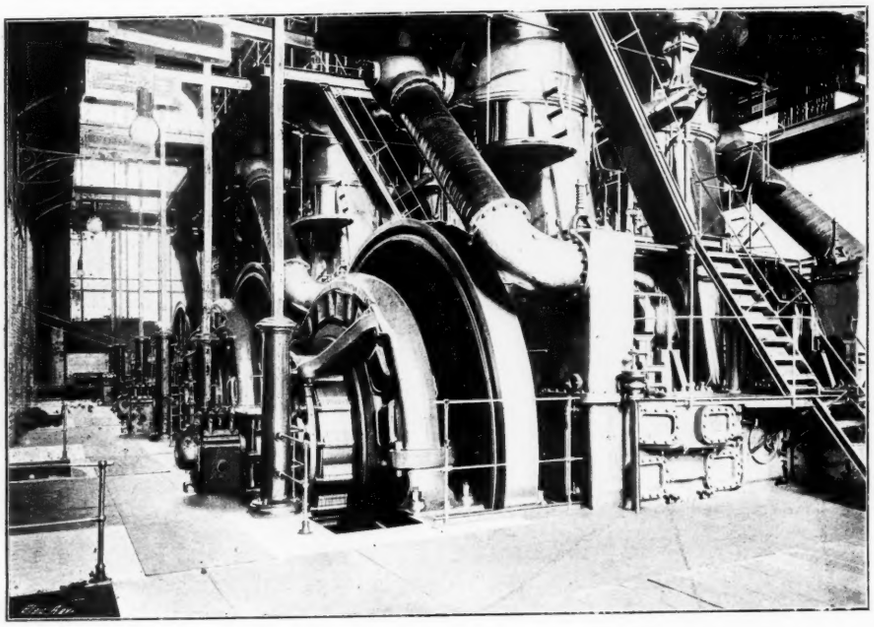
A model of the Archbutt-Deeley water-softening process, and a variety of feed-water filters, duplex pumps, &c., are shown, but cannot be described at this time.



Glasgow Exhibition: Variable Throw Feed Pump.



Berlin: Cable Tunnel.

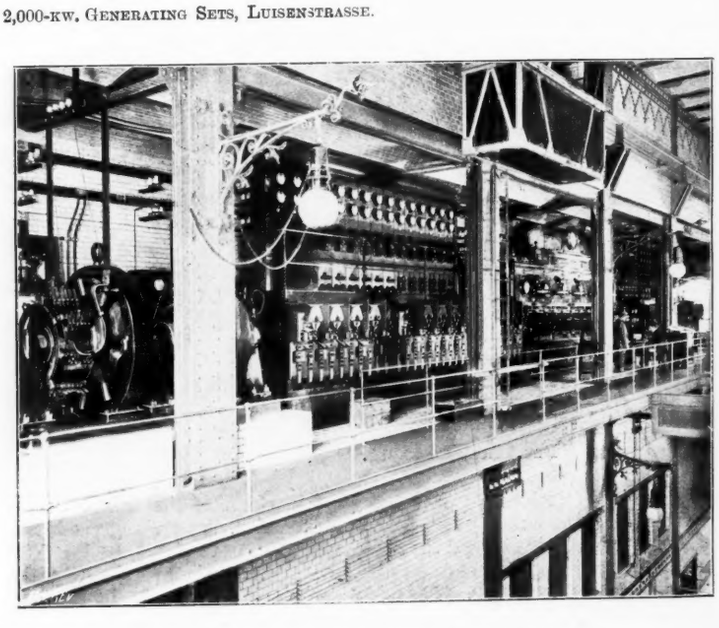


Berlin: 2,000-kw. Generating Sets, Luisenstrasse.

THE INSTITUTION OF ELECTRICAL ENGINEERS IN GERMANY.

III.

On the conclusion of the demonstration of the Nernst lamp, the visitors proceeded to inspect the adjoining electricity works—the Schiffbauerdamm station, one of the earlier installations, and the Luisenstrasse station, which is practically an extension of the former. These taken together form one of the six stations which supply Berlin with electric light and power; all these are the property of a single company, the Berliner Elektricitäts Werke, which was founded by the Allgemeine Elecktricitäts Gesellschaft (at that time known as the German Edison Company) in 1884, and which has grown to be one of the most important concerns of the kind in existence. The company concluded an agreement with the Municipality of Berlin, which provided for the purchase of the undertaking after a space of 10



Berlin: Switchboard Gallery, Luisenstrasse.

years, and again at five-year intervals, and stipulated that 10 per cent. of the profits should be paid to the city for the concession, as well as 25 per cent. of the surplus after a dividend of 6 per cent. had been paid to the shareholders. The supply was carried out on the direct current three-wire system, at 110 volts. The demand rapidly increased, and it was found necessary to erect new stations from time to time; powers were also obtained in 1888 to increase the area supplied, and the tramways which were laid down in Berlin took their supply of energy from the company's generating stations, so that the aggregate capacity of the plant installed has now reached the enormous total of over 140,000 H.P. In December last, 8,000 motors were connected to the system, with 400,000 glow lamps, and 16,000 arcs. The mains consist mostly of a closed network, fed at numerous points from the generating stations and from six sub-stations; most of the stations generate direct current, but the two last erected—Oberspree and Moabit—generate current on the three-phase system at 6,000 volts, and transmit it to converting stations in the city. Some three-phase plant is also installed at the Schiffbauerdamm station for the purpose of assisting the Markgrafenstrasse station, which supplies power mainly to the tramways and cannot be extended to cope with the load.

The Schiffbauerdamm station is equipped with 11 Steinmüller water-tube boilers and five engine sets. Three of the latter each consist of a 1,000-H.P. Van den Kerchove engine, of the vertical compound Corliss type, running at 70 revolutions per minute, and driving direct two dynamos, one at either end of the shaft. Each of these machines has an output of 364 KW.—2,600 amperes at 140 volts. They are of the type once very popular on the Continent—having internal field magnets with a ring armature outside them, the outer bars of which serve for a commutator. The two remaining sets consist each of a 2,000-H.P. Görlitz engine, with Collmann valve gear, direct coupled to two three-phase inductor alternators of 700 KW. each at 3,000 volts.

The Luisenstrasse station is remarkable for the arrangement of the boilers, which are placed on the top floor of the building. They are eight in number, of the Heine water-tube type, working at 200 lbs. per sq. in. Economisers and condensing apparatus are used, and the steam is superheated to about 300° C. Coal conveyors are provided to take the coal up to the boiler house floor. The station contains three generating sets; each of these consists of a Sulzer engine of the triple-expansion type, with two cranks and four cylinders, rated to give 3,000 H.P. at 85 revolutions per minute. Each of these engines is coupled to two direct current dynamos. The latter are of the external field type, with 16 poles each, and are rated at 1,000 KW. at 250—280 volts. They are generally used for tramway working, coupled two in series. It is stated that with these sets the KW.-hour can be generated for an expenditure of only 12·6 lbs. of steam, and 1·6 lbs. of coal! The station is equipped with two batteries for balancing the lighting circuits, of 140 cells each, of 2,600 ampere-hours' capacity when discharged in three hours. There is also a battery of 256 cells for the tramways, having a capacity of 1,400 ampere-hours at a one-hour rate of discharge. These are charged by means of boosters, and other boosters are connected in series with the tramway feeders to regulate the pressure.

Our illustrations show the steam dynamos and switchboard of the Luisenstrasse station, as well as one of the cable tunnels under the building, with the cables in position.

American Electrical Competition in India.—We have over and over again used our influence in the columns of the ELECTRICAL REVIEW to persuade British electrical engineers and promoters to turn their search lights direct on India, and to do their level best to keep possession of the market so far as possible. The urgent necessity for following this advice is emphasised by a sentence which appeared in the *Financial News* last week:—"It is believed that a wealthy American syndicate will shortly approach the municipalities of all the large towns of India not provided with electric installations, with a view to remedying the deficiency."

ELECTRIC TRACTION NOTES.

(*Continued from page* 514.)

Preston.—An inquiry was held on Tuesday at the Guildhall, Preston, by the Earl of Jersey and Colonel Boughey, Light Railway Commissioners, respecting applications by the Auxiliary and Light Railways and Tramways Company, Limited, for orders to authorise the laying down of light railways from Lytham to Preston and from Preston to Horwich. After hearing certain evidence, the Commissioners decided that they could not go on with the hearing as they were not satisfied with the way in which the financial position had been put forward.

Swadlincote.—Mr. C. H. Gadsby, of Westminster, has informed the U.D.C. that a syndicate is in course of formation which proposes to make application to the Light Railway Commissioners for an order to authorise the construction of electric tramways from Burton through Newhall, Swadlincote and Woodville, to Ashby, with a branch line through Gresley. A committee recommended the Council to approve of the principle of the scheme.

The Underground.—Mr. Yerkes, interviewed by a daily press representative, says that unnecessary delay is likely to occur in connection with the electrical conversion question, through the attitude of the Metropolitan directors in requesting that no action shall be taken by the Board of Arbitration for a period of nearly two months—namely, till November 15th.

Walton-on-the-Naze.—A young man (18) crossed the pier electric railway (third rail) to moor a boat to the pier one day last week, and was subsequently found lying across the rails. Those on the spot not being familiar with the means for rescuing him, were unable to render assistance for fear of shock. The unfortunate man struggled and fell between the rails head first into the sea, and death occurred, as the medical evidence showed, from drowning. A verdict of "Accidental death" was returned.

TELEGRAPH AND TELEPHONE NOTES.

American Pacific Cable.—The *Daily Telegraph* New York correspondent says:—"The Commercial Pacific Cable Company has been incorporated at Albany, with a capital of $100,000, to connect New York City with San Francisco by its own or other telegraph lines, and thence to run from California under the Pacific Ocean to Hawaii, the Philippines, and other Pacific islands. The directors are Messrs. John W. Mackay, Clarence Mackay, G. G. Ward, Albert Beck, William C. Cook, A. B. Chandler, Edward C. Platt, and George Clapperton. Mr. Mackay said to me to-day: 'The length of the cable will be about 8,500 miles. The first part will be laid from California to the Hawaiian Islands, 2,200 miles. It is expected that this portion will be completed and in operation in nine months.' He says he believes that the entire line to the Philippines will be ready in two years. Mr. Mackay added that his applications to Government for landing rights in California, the Hawaiian Islands and the Philippines, were still pending; but, in view of the fact that the new company was willing to construct and lay the cable without asking for any subsidy or guarantee, he believed there would be no trouble as to the terms and conditions upon which the cable will be landed when it reaches the Philippines. It will connect with the present cable running to Japan, and with the cable running to China, thus establishing direct cable communication between China and the United States. Mr. Mackay also informed me that the present telegraphic rates from the States to the Philippines, China and Japan would be reduced by this line from 30 to 60 per cent."

International Telephones.—A financial contemporary says that the first international telephone connection of Italy will shortly be brought into operation by the completion of the line between Milan, Turin and Paris *viâ* the Mont Cenis. The institution of this service will a few months later be followed by the inauguration of a telephone line affording a means of communication between Milan and Zurich, there only now remaining to be constructed the section between Como and Chiasso on the Swiss frontier. By the establishment of these lines Italy will be placed in telephonic communication with London by way of the Paris system and with Berlin through the Zurich line. It is, however, believed that negotiations are on the point of being entered into with a view to the erection of a direct telephone line between Milan and Berlin, whilst many improvements in the inland telephone and telegraph service are projected by the Italian Government.

National Telephone Company v. Richards.—On Thursday last week at the Wolverhampton County Court, before Judge Howland Roberts, an action interesting to telephone users was heard, in which the manager of the Wolverhampton branch of the National Telephone Company sued Mr. Wm. Richards, of the Empire Cycle Works, Wolverhampton, for the recovery of £18, two years' rental for the use of the telephone. Mr. S. R. Rhodes, solicitor, in stating the case for the plaintiff company, said the defendant had entered into an agreement with the company, dated February 26th, 1896, to supply him with telephonic communication for a term of four years at the annual rental of £9, each year's rent to be paid in advance. Although the written agreement was only

for four years, it was in reality a continuing agreement until terminated by six months' notice on either side. Clause 7 of the company's regulations provided that if the annual rental at any time became in arrear for the period of one calendar month, or a subscriber became bankrupt (or for other causes therein stated), the company might terminate the agreement at any time by giving notice in writing. Another clause in the agreement states:—"The company reserve to themselves the right, without prejudice to any of the other clauses of the agreement, to disconnect any subscriber whose rent is in arrear." In June, 1900, the advance rent due in February not having been paid by the defendant, the company, in accordance with their rights under the terms of agreement, disconnected defendant's telephone. But this did not, contended Mr. Rhodes, exonerate defendant from the continuing rent, he not having given the six months' notice required to cease his connection. The company, therefore, claimed from him two years' rental from February 26th, 1900, to February 26th, 1902. Mr. Haslam, who represented the defendant, said his defence was that his client, having been disconnected by the telephone company on June 19th, 1900, became no longer liable for the rent. He held that the agreement with the company, as interpreted by Mr. Rhodes, as a continuing agreement would not hold good. The agreement itself was in writing and was for a period of four years only, dating from June, 1896, when the telephonic connection first commenced, to June, 1900. For the company to terminate the connection, and then to claim a continuing rental for the subsequent two years, was, he contended, a most arbitrary proceeding. The Judge gave his decision in favour of the company for one year's rental only, holding that the company, having terminated the agreement by disconnecting the supply, were only entitled to the rent for the current year in which such disconnection took place. At the same time he expressed his willingness to grant a case for appeal on the point as to whether the company were entitled to claim rental for the second year.

Southport Telephones.—A report on municipal telephones has been adopted by the T.C. The sub-committee after visiting Glasgow, Tunbridge Wells and Guernsey suggest a municipal telephone exchange for Southport at a subscription of £6 per annum, and at an estimated capital expenditure of £10,705. With 450 subscribers it is thought that on these terms there would be a profit of £130.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Cadiz-Teneriffe	Aug. 6, 1901	
Bissao-Bolama	Aug. 16, 1901	
Curacao-Coro	Sept. 5, 1901	
Gibraltar-Tangier	Sept. 13, 1901	
Landlines:—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	
Communication with Baranquilla and Cartagena	Dec. 8, 1900	
" towns of Venezuela	Oct. 31, 1900	

CONTRACTS OPEN AND CLOSED.

OPEN.

Boulder City.—November 23rd. The Council invite tenders from manufacturers for the construction of a tramways system, plans and specifications of which are to be seen at the office of the Agent-General, London. See "Official Notices" September 20th.

Blackpool.—October 21st. Tramway poles, cables, overhead work, electric car equipment, &c., for the Corporation. See "Official Notices" to-day.

Bray.—October 3rd. Twelve months electrical supplies for the electric light works. See "Official Notices" September 13th.

Colne.—September 28th. Wiring the Town Hall and Market Hall. Corporation. See "Official Notices" September 20th.

Doncaster.—September 27th. Tenders for a 220-KW. high speed steam dynamo, piping, valves, &c. See "Official Notices" September 13th.

France.—October 1st. The French Post and Telegraph Authorities in Paris are inviting tenders for the supply of a multiple telephone table for the telephone exchange at Lille. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—The Prefect of the Haute Garonne is open to offers from would-be concessionnaires for the construction of the following lines to be worked electrically; from Saint Gaudenes to Aspet; *viâ* Pointis-Inard; the valley of the Azize; from Toulouse to Saint Sulpice to Lezat; from Toulouse to Castres *via* Lanta and Caraman, and from Caraman to Revel. Intending concessionnaires should follow as nearly as possible the plans that have already been prepared.

Greenwich.—October 10th. Installation for lighting the new Children's Homes for the Guardians. See "Official Notices" September 20th.

Hackney.—October 7th. The electric lighting of the Hackney Workmen's Club, 27, Haggerston Road. Can be viewed 11 a.m. to 3 p.m. W.McNiell, secretary.

Huddersfield.—September 30th. One set of 600-KW. alternating current generating plant for the electricity works. See "Official Notices" September 13th.

Huddersfield.—October 12th. Six car bodies, trucks and equipments. Corporation. See "Official Notices" September 20th.

Hull.—September 27th. Two steam dynamos, arc and incandescent wiring for the destructor, sanitary departments, &c. Corporation. See "Official Notices" September 20th.

Kirkcaldy.—October 14th. Main switchboard. Corporation. See "Official Notices" September 20th.

Leeds.—October 8th. Main switchboard to deal with output of three 1,500-KW. two-phase alternators. See "Official Notices" September 13th.

Leeds.—October 15th. Fifty electric tramcars. Deposit 10 guineas to T. Hewson, City Engineer, Municipal Buildings, or Hopkinson & Talbot.

Manchester.—October 2nd. Ampere-hour and watt-hour meters for the Electricity Committee. See "Official Notices" September 20th.

Manchester.—October 9th. Tenders for cables for Electricity Committee:—

(*a*) Three-core three-phase high tension feeders, approximate length 7¼ miles; (*b*) Traction feeders, approximate length 7 miles; (*c*) Lighting feeders, approximate length 3½ miles; (*d*) Distributors, approximate length 33 miles; (*e*) Potential wires, approximate length 11¼ miles; (*f*) Arc lighting cables, approximate length 15½ miles; (*g*) Telephone cables, approximate length 3½ miles. Total 147¾ miles.

Specifications and drawings may be inspected (but not obtained) at the offices of the Chief Engineer, Dickinson Street. See "Official Notices" to-day.

Newport (Mon.).—October 21st. Coal handling winches, piping, switchboard, cables, cable ways, overhead construction, electric motor car, repair shop equipment, and steel chimney shaft for the tramways and power supply undertaking. See "Official Notices" September 20th.

Poplar.—October 1st. Electric lighting of four public libraries. See "Official Notices" September 13th.

Rochdale.—October 2nd. The Electricity Committee wants tenders for feeder and distributor cables. See "Official Notices" September 13th.

Sheffield.—September 30th. Boilers, motors, fans, iron chimneys, &c., for the electricity department. See "Official Notices" September 6th.

Stepney.—October 17th. Arc lamp columns, lamps, fittings, switchboard, for Council's electricity works. See "Official Notices" to-day.

Wakefield.—October 15th. One 550-B.H.P. high speed engine and one 400-KW. two-phase alternator. See "Official Notices" to-day.

Willesden.—Economisers, boilers, piping and pumps, steam dynamos, battery, wiring, &c., for electricity works for the Willesden Infirmary. See "Official Notices" September 6th.

CLOSED.

Brighton.—The Pavilion Committee received tenders as follows for electric lighting work in a portion of the Royal Pavilion:—

G. Hignett & Co., Brighton (*accepted*)	£309 15 0
H. J. Galliers, Brighton	360 0 0
J. F. Phillips & Sons, Brighton	380 0 0
M. A. Fileman, Brighton	398 0 0
C. Hawkes & Walton, Brighton	398 19 6
Reed & Sons, Brighton	485 10 0

Cleckheaton.—The U.D.C. has accepted the following tenders:—The Johnson-Lundell Electric Traction Company, Limited, for the supply and erection of three steam engines and three electric generators; the Electrical Power Storage Company, Limited, accumulators for electric lighting; the British Insulated Wire Company, Limited, electric cables; the Phœnix Dynamo Manufacturing Company, balancer and booster sets; Messrs. Dorman & Smith, switchboards; Messrs. Meldrum Bros., Limited, two 2-grate Regenerator "Simplex" refuse destructor furnaces; and Messrs. James Spencer & Co., travelling crane. After considering the tenders for boilers, economisers, condenser and pumps, it was resolved that further tenders be invited for the supply of each separately.

Deptford.—The Borough Council have accepted the tender of the Hart Accumulator Company to erect at the local baths 45 of their standard lighting type cells at £112.

Lancaster.—The Electricity Committee has accepted the tender of Messrs. Sharp & Co., of Phœnix Foundry, Lancaster, for condensing plant costing £1,410.

Bournemouth.—The Town Council at their meeting on 19th inst., on the advice of Messrs. Lacey, Clirehugh & Sillar, accepted tenders for various works on the new tramway system for the town.

Contract No. 3.—Section A, boilers, mechanical stokers and fittings; B, superheaters; C, economisers; D, feed pipes, pumps, tanks, meters, &c.; E, steam and exhaust pipes, condenser pipes, valves and accessories.

Section.	J. Thompson.	Fraser & Son.	Tinkers.	Yates & Thom.	Danks & Co. (accepted.)
A	£5,000	£4,072	£4,980	£4,061	£3,610
B	1,750	1,400	1,452	1,465	1,415
C	1,500	844	801	812	835
D	2,750	1,734	2,320	1,772	1,255
E	7,000	5,285	3,840	3,767	2,285
	£18,000	£13,339	£12,793	£11,877	£9,400

Babcock & Wilcox tender incomplete.

Water Cooler.

W. Watson	£3,570
The Wheeler Condenser Company	1,721
Messrs. Doherty & Donat	880
Klein Engineering Co., £859—Cooling surface 106,000 sq. ft.	(accepted)
Couper Schwarz, £773—Cooling surface 26,000 sq. ft.	
A. Koppel, £730—Cooling surface 36,432 sq. ft.	

The engineers reported as follows:—

You will note that the cooling surface proposed by the Klein Engineering Co. is 106,000 sq. ft., whereas the cooling surfaces proposed by Couper Schwarz, and by A. Koppel, are only 26,000 sq. ft., and 36,432 sq. ft. respectively. The proper cooling of the water depends to a very great extent upon the cooling surface, and having regard to this fact, we would recommend the acceptance of the tender from the Klein Engineering Company, although such tender is slightly in excess of those from Couper Schwarz and A. Koppel.

Travelling Crane.

Messrs. H. Morris & Bastert	£1,450
„ Carrick & Ritchie (accepted)	365
Chatteris Engineering Works	363
Messrs. J. Spencer & Co.	350
„ J. Carrick & Son	326
„ J. Hitchen & Sons	285

A, steel grooved girder rails, &c.; B, permanent way construction and rail bonding; C, wood block, tar macadam and granite sett paving.

	A	B	C	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Wm. Griffiths & Co.	18,860 2 8	37,546 13 11	37,480 18 5	93,887 14 7
Deduction				332 16 6
				93,514 18 1
White & Co. (accepted)	15,743 0 0	29,687 15 9	48,290 7 6	93,721 3 3
Deduction				100 0 0
				93,621 3 3
Dick, Kerr & Co.	16,237 16 4	43,682 15 7	52,143 17 7	112,264 9 6
Addition				1,124 10 3
				113,183 19 9
W. M. Murphy	21,802 0 0	53,610 0 0	49,541 0 0	124,953 0 0
Deduction				3,453 0 0
				121,500 0 0
E. Nuttall	15,194 11 3	42,507 17 10	42,056 2 0	99,758 11 1
No deduction				
Macartney, McElroy & Co.	17,083 13 5	38,524 5 9	39,627 11 4	95,235 10 6
Addition				2,805 9 1
				98,040 19 7
B. Coolee & Co.	20,645 15 0	42,005 6 7	44,148 18 5	106,800 0 0
Addition				1,500 0 0
				108,300 0 0
Geo. Law	22,836 9 0	53,710 16 4	52,440 7 6	128,987 12 10
Addition				3,081 18 6
				132,069 11 0

A, steel grooved girder rails, &c.; B, conduit, permanent way construction, and rail bonding, &c.; C, ploughs and carrying attachment to cars; D, wood block, tar macadam, and granite sett paving.

	A	B	C	D	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
White & Co. (accepted)	4,055 8 6	26,931 3 4	2,000 0 0	25,630 8 0	58,617 0 0
Deduct					465 0 0
					58,152 0 0
Dick, Kerr & Co.	4,206 15 0	30,000 0 0	2,525 0 0	26,925 10 0	63,657 5 0
No deduction.					
Griffith	2,595 0 0	41,289 0 0	250 0 0	16,171 0 0	60,306 0 0
No deduction.					
British Thomson-Houston	4,570 0 0	31,175 0 0	2,376 0 0	29,648 0 0	67,709 0 0
No deduction.					
British Westinghouse	3,093 2 0	27,493 13 4	444 13 6	28,084 15 11	59,116 4 5
No deduction.					

Halifax.—The tender of Messrs. N. Nunns & Co. has been accepted for the installation of the electric light throughout the new school erecting in Battinson Road by the Halifax School Board. The amount of the tender is £284 12s. 6d. Another similar tender will shortly be in the market at Halifax, the School Board having this week accepted plans for a new infant school, to be erected at Haugh Shaw, in which the electric light has to be installed.

Heckmondwike.—The D.C. has accepted the tender of Babcock & Wilcox for an additional boiler, pipework, &c., for the electricity works.

Southend-on-Sea.—The T.C. have accepted the tender of Callender's Cable and Construction Company, at £11,891, for the laying of the cables and other work in connection with the electric lighting scheme.

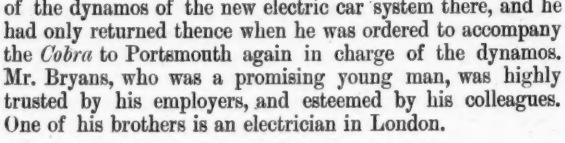
NOTES.

Obituary.—We referred very briefly last week to the death of Mr. Goolden. The following notes amplifying our previous comments will be of interest both to those who knew him personally and to those who merely remember him by name as one of our early workers in electrical engineering. Walter Thomas Goolden was born in 1848, his father being a medical man. After leaving school he went to Magdalen College, Oxford, became science scholar at Merton College in 1867, and took a first class degree in Natural Science in 1871. He seems at one time to have contemplated going into the medical profession, and studied medicine, and his knowledge in this direction often proved unexpectedly useful, but ultimately he took up scholastic work, and was at one time master at Tonbridge School. At the time of the Fisheries Exhibition he became much interested in the developments of electric lighting, and joined Mr. Henry Edmunds to form the firm of Edmunds and Goolden; a factory was established in Halifax to develop the Hochhausen system of arc lighting. Out of this grew the developments in incandescent lighting machines, and when after a time Mr. Edmunds retired from the business, Mr. Goolden was joined by Mr. A. P. Trotter, and the firm became Goolden and Trotter. Mr. Goolden lived in London, and Mr. Trotter had charge of the technical side of the business in Halifax. During these years the industry was developing rapidly, and the firm of Goolden & Trotter was recognised as being well to the front. When Mr. Trotter retired from the business to take up the more scientific side of electrical engineering, Mr. Goolden took into partnership Mr. Llewellyn B. Atkinson, and in 1888, the factory in Halifax having become too small for the growing business, a move was made to London, and the Woodfield works were equipped. Hither also was moved the electrical instrument business which Mr. Goolden had started in London in charge of Mr. S. Evershed. In 1893, the works having again become too small for the growing business, Mr. Goolden's firm amalgamated with the firm of Easton & Anderson under the title of Easton, Anderson & Goolden, Limited, and Mr. Goolden became a director. In 1895 Mr. Goolden took the management of the North of England business of this company, and also became managing director of the Electrical Coal Cutting Company, in which capacity he devoted much attention and time to the problems of coal mining by machinery. In 1898 Mr. Goolden ceased to be a director of Messrs. Easton, Anderson & Goolden, Limited, and practised as a consultant, his experience in electric mining work in particular being considerably sought after. He also became managing director of the Typewriting Telegraph Corporation. He had always retained to some extent his touch with educational matters, and was for some years examiner to the Civil Service Commission in science subjects, and assistant examiner in Natural Philosophy to the London University; he was also one of the science examiners to the Science and Art Department of South Kensington. Mr. Goolden was of a somewhat retiring nature, and for this reason took little active part in the proceedings of the Institution of Electrical Engineers, of which he was a member, and at one time a member of Council. About two years ago he met with an accident in getting into an omnibus, and was laid up for some time; this seemed to affect his general health, and it was observed by his friends that he never seemed so well afterwards. A year ago he began to have heart trouble, and although it was hoped that rest would relieve him, it was not so; on September 16th, at the early age of 52, he died at Cookham at the residence of his sister, and was interred at Boyne Hill Churchyard, Maidenhead. There is no doubt that the anxious work in which he had been engaged for many years in pioneering the early development

of electrical engineering, when the uncertainties arising from want of experience in each new development undertaken were much greater than now exist, had done much to lead towards so early a close to his life. He was endeared to all who knew and worked with him by his genial manner and genuine kindness, being ever ready to give the credit of successful work in which he shared to his colleagues, and by his death electrical engineering loses a man and a name which had done much to make it what it is to-day.

The loss of the torpedo destroyer *Cobra* last week resulted in the drowning of Mr. Alfred Bryans, a native of Sunderland, who had been employed by Messrs. Parsons as an electrician for some considerable time, and who was highly esteemed by them. When H.M.S. *Viper*, which was wrecked a few months ago, was sent from the Tyne to Portsmouth, Mr. Bryans went round with her to superintend the dynamos until the vessel was taken over by the Admiralty. On his return he was sent by Messrs. Parsons to Stockport in charge of the dynamos of the new electric car system there, and he had only returned thence when he was ordered to accompany the *Cobra* to Portsmouth again in charge of the dynamos. Mr. Bryans, who was a promising young man, was highly trusted by his employers, and esteemed by his colleagues. One of his brothers is an electrician in London.

Continuous Current Dynamos.—In the article on this subject, contributed by Mr. Claude W. Hill to our last number, reference was made on p. 463 to a curve which



Mr. Hill had found very useful in estimating the cost of new machines forming part of a series. This curve was accidentally confused with one of the figures given in Mr. Mavor's paper; the correct curve is given herewith.

Walthamstow Electricity Works.—On Friday last, 20th inst., the electricity works, which have been put down by the Walthamstow District Council to the plans of Mr. J. Enright, were inaugurated with the usual ceremony, this being performed by Mr. Councillor Friend, the chairman of the Lighting Committee. The buildings were erected by the Council's own workmen, and the plant and machinery contract was given to Messrs. Frank Suter & Co., Limited. The station is gas driven, a Dowson gas producer plant supplying gas for driving three Westinghouse gas engines of the three-crank type, each of about 100 B.H.P. The Helios dynamos are direct coupled, and there is a battery of Tudor cells, boosters, and a balancer. The mains were supplied and laid by Henley's Company, and for the street lighting, which consists of 63 arcs, with midnight incandescents, Messrs. Oliver & Co., Limited, were responsible. Glow lamps will soon replace the gas jets in the side streets. Mr. F. A. Wilkinson is the resident electrical engineer.

The Italian Electro-Technical Association.—The annual general meeting of the Associazione Elettrotecnica Italiana (Italian Electro-Technical Association) will be held in Rome from October 12th to 15th. The morning of Saturday, October 12th, will be devoted to business, and in the afternoon the following papers will be read:—"On the Construction of Permanent Magnets," by Prof. Moisè Ascoli; "The Claims to the Priority of Invention of the Meucci Telephone," by Prof. Angelo Banti; and "Electric Accumulators," by Ing. Gustavo Dossmann. On Sunday, October 13th, the first business will be the presentation of the report of the Commission on the Sacchi-Strazza premium competition, after which a number of papers will be read, as follows:—"Electro-Magnetic Units," by Ing. Giovanni Giorgi; "Electric Traction on Navigable Canals in Italy," by Ing. Ernesto Fumero; "The Inductive Effect of High Tension Conductors on Telephone Lines and the Means of Obviating the Same," by Ing. Angelo Silva; and "The Electro-Thermic Industry," by Prof. Ferdinando Lori. The projected "Regulations for Safety in Electrical Plants," brought forward a year ago, will then be discussed and voted upon. Monday, October 14th, will be devoted to a visit to Tivoli, near Rome, where the plant of the Società Anglo-Romano per l'Illuminazione, Prof. Garuti's plant for the electrolysis of water, and the old Gaulard & Gibbs Tivoli lighting plant will be inspected. On Tuesday, October 15th, the Cerchi and Porta Pia central electric lighting stations, and the chief telegraph and telephone offices in Rome, will be visited, while on Wednesday, October 16th, an excursion will be made to Terni, where the members will inspect the large steel works and other industrial establishments. The Italian Ministry of Marine is arranging to shortly make some experiments with wireless telegraphy, and if these take place during the week of the meeting, an excursion will be organised in order that the members of the Association may be present at the trials.

British Electric Works Company, Limited.—Following the recent action brought by Mr. Walter Glynn, against the directors of the British Electrical Works Company, Limited, and the decision given against the directors in the action, negotiations were opened on behalf of the directors with other shareholders, who were likely to make claims under the decision. A meeting of shareholders of the company was held at Liverpool last week, at which the results of the negotiations were made known. It was announced that the directors had agreed that all the original allotters of shares in the company who held shares at the date of the liquidation should be paid in full, in respect of such shares. Payment would be made by instalments. The scheme was approved of by the meeting, and Messrs. Walter Glynn and L. S. Cohen were appointed trustees for the shareholders. The arrangement will prevent the further anticipated litigation, and will be satisfactory to the original shareholders of the company, as under it they will receive back 20s. in the pound for money invested on the faith of the prospectus.

Correction.—In our article on Farnworth last week, an unfortunate error occurred in connection with the boiler feed pumps. These were, in fact, supplied by Messrs. J. P. Hall & Sons, Limited, of Peterborough; they are of the "Hall" patent vertical compound direct-acting type, and are in duplicate. Each pump is capable of delivering 2,000 gallons of water per hour, against the boiler pressure, at a piston speed of 30 ft. per minute. These pumps, it seems, judging by the contracts recently placed, have found considerable favour amongst station engineers, in the short time since their manufacture was commenced.

Shock Fatality.—Mr. A. S. Fildes, the foreman of the Bangkok branch of Messrs. Howarth, Erskine & Co., Limited, was recently killed by electric shock, while superintending certain operations in connection with the electric tramway system.

Glasgow Subway and Electricity.—Someone has been advocating cheaper fares for the Glasgow District Subway, but it seems that until electricity is employed there is very little likelihood of this being possible. Other remarks also indicate that electric traction may come before long.

Glasgow Exhibition.—A total attendance of 171,960 was registered on 23rd inst., being 35,000 more than the previous record. All the main buildings are now illuminated in the evening with electricity.

Personal.—We learn that Messrs. William McLean and Co., of Melbourne, are sending their manager, Mr. O. L. Remington, on a tour of inspection of the electrical and manufacturing industries of Europe and America. They are taking this action because of the impetus that is expected to be given to Australian trade and enterprise in general as a result of the abolition of the interstate customs tariffs, &c., and with a view to adding to their already large line of specialities, such other manufactures as may commend themselves to Mr. Remington. For the information of those who may wish to place themselves in communication with that gentleman, we may add that his head-quarters, while in this country, will be Hotel St. James, London, where he arrives about October 5th.

Mr. Norman A. Thompson, A.I.E.E., has resigned the secretaryship of the Tramways and Light Railways Association to take up an appointment with the Allgemeine Electric Company, 25, Victoria Street, S.W., as commercial electrical engineer. Mr. Thompson is proceeding to Berlin, where, we understand, he will remain for two or three months with the Allgemeine Elektricitäts Gesellschaft. His place as secretary to the Tramways and Light Railways Association is taken by Mr. Cyril E. Browne, M.A.

Mr. C. Hutchinson, late of Belliss & Morcom, Limited, has been appointed assistant electrical engineer at Barnes by the U.D.C.

Mr. Walter Vaux, who, since 1882, has been manager of the Bradford Tramways and Omnibus Company's steam and horse-car services, has been appointed general manager to the South Lancashire Electric Tramways Company.

Mr. F. C. Armstrong, of Dick, Kerr & Co., has just been for a fortnight's visit in the States.

Prof. Sidney H. Short is going on a trip to America during October.

Mr. E. S. Haslam, the departing mains superintendent of the Hastings Corporation electric light works, was on Wednesday last week presented with a dressing bag and an illuminated address on the occasion of his leaving to join the staff of Messrs. Preece & Cardew. Mr. Dudding made the presentation, on behalf of the staff and employés.

Last Friday Mr. H. W. W. Dix, assistant chief draughtsman to Messrs. Crompton & Co., Limited, Chelmsford, was presented with an oak stationery cabinet and dressing bag, together with a framed illuminated address signed by members of the technical staff and others, expressive of their appreciation and respect. Mr. Dix has been connected with Messrs. Crompton & Co., Limited, for the past nine years.

The Finchley U.D.C. has appointed Mr. E. Calvert, of Buxton, as resident electrical engineer, at a salary of £300 per annum.

Electric Shock Fatalities.—The *Liverpool Mercury* says that on Tuesday William Moore, a man employed at Exhall Colliery, Warwickshire, was killed by electric shock while roof repairing. A heavy steel bar broke the guard protecting the electric wires.

On Tuesday last week, while painting the electric tramway standards at Ayr, a man named Connor came into contact with the overhead wire and fell to the ground. He was picked up unconscious and conveyed to the hospital.

An Automobile Smash.—In the *Times* of Wednesday we find a report of a serious automobile accident which occurred at Valkenburg on the occasion of the Dutch army manœuvres. The casualty list of foreign officers who rode in this runaway and restive beast is distressingly lengthy and detailed, and the only consoling feature about the affair is that the British Military Attaché escaped unhurt. The reason of his escape is quite simple, for he had chosen horseback in preference to the automobile. This affair seems to give some support to the recent suggestion that there should be specially constructed roads for motorcars in the future, instead of putting down so many tramways!

Appointments Vacant.—A chief assistant engineer is wanted for the Wimbledon electricity works, at £150, rising to £200; an engineer-in-charge at £150, and an assistant engineer at £120 for Poplar electricity works. A shift engineer is required at Blackburn.

Finsbury Technical College.—The Winter Session of the Technical College, Finsbury, begins on Monday next, the 30th inst. Prof. Silvanus Thompson will lecture on Mondays on the "Design of Generators and Motors." On Wednesdays the lectures by Prof. Thompson or by Mr. Verity will deal with "Electro-Magnetism and Electric Measurement." A special course of six lectures on "Insulation" will be delivered on Thursdays, commencing October 10th, by Mr. Mervyn O'Gorman.

Late Correspondence.—A letter from Mr. H. Leitner in regard to Mr. R. Kennedy's article in our September 13th issue, and a letter by "C. E. D." on "Coal Consumption," have come to hand too late for insertion this week. We shall publish them in our next issue.

Electricity in Warships.—The *Daily Telegraph* reports that the extension in the use of electricity in his Majesty's warships in place of steam for subsidiary purposes is to be made the subject of a series of experimental tests in November.

Society Notice.—The Civil and Mechanical Engineers' Society will during the coming session meet at St. Ermin's Hotel, Caxton Street, Westminster. The first meeting is to be held next Thursday, October 3rd, when the president, Prof. R. H. Smith, will deliver an address on "Factors of Safety."

Mishaps.—One of the locomotives jumped the crossing points at Shepherd's Bush on Wednesday morning, and the service was thrown out for a considerable time in consequence. A breakdown of a trolley wire on the L.U. tramways in Acton Lane also occurred the same morning and temporarily suspended the service.

London Electrical Contractors' Association.—The first general meeting of the above Association was held at Anderton's Hotel, Fleet Street, on Thursday, September 26th, at 3 p.m.

Isle of Man.—As we go to press we learn that the liquidator has accepted the offer of £50,000 from the Douglas Corporation for the horse and cable sections, which will be electrified at a cost of £105,000. Sir Jas. Gell, Chancery Judge, on Wednesday authorised the sale.

NEW COMPANY REGISTERED.

Ilfracombe Electric Light and Power Company, Limited (71,378).—This company was registered on September 16th, with a capital of £15,000 in £5 shares, to carry on the business of electrical engineers, electricians, practical engineers, contractors, manufacturers of electrical apparatus, producers of light, heat, sound and power by electricity, galvanism or magnetism, &c. The first subscribers (each with one share) are:—F. E. Gripper, Broad Sanctuary Chambers, Westminster, engineers; A. Anderson, 11, Grandison Road, S.W., engineer; H. J. Read, Greenfield, Liverpool Road, St. Albans, electrical engineer; F. Payton, 71, Page Street, Westminster, S.W., secretary; G. F. Barrow, 45, Munster Square, Regent's Park, N.W., clerk; H. J. Stewart, 180, Shirland Road, Paddington, W., clerk; and L. A. Hard, Broad Sanctuary Chambers, Westminster, electrical engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 20 shares; remuneration as fixed by the company. Registered office, Broad Sanctuary Chambers, Westminster, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Globe Telegraph and Trust Company, Limited (7,465 C).—This company's annual return was filed on August 20th, when 180,042 preference and 180,227 ordinary shares were taken up out of a nominal capital of £5,000,000 in 250,000 preference and 250,000 ordinary shares of £10 each; £10 per share has been called up, resulting in the receipt of £3,602,690. No mortgages or charges.

Thomas Parker, Limited (40,973).—This company's annual return was filed on July 24th, when the entire capital of £75,000 in 7,500 shares of £10 each, had been taken up. £10 has been called up on each of the 5,750 shares, resulting in the receipt of £57,500. £17,500 considered as paid on 1,750 shares. Mortgages and charges, £57,100. Particulars of registered mortgages and charges:—Total amount secured by series of debentures, £75,000; date of resolution creating series of debentures, June 23rd, 1898; dates and amounts of issues now registered: (*a*) February 27th, 1901, £300; (*b*) April 29th, 1901, £500; (*c*) July 29th, 1901, £200; property charged: The undertaking and property, present and future, of the company; trustees, none; dates of registration: (*a*) March 2nd, 1901; (*b*) May 2nd, 1901; (*c*) August 2nd, 1901; total amount issued of same series prior to first registration (*a*) mentioned above, £56,300.

British Electric Traction Company, Limited (49,855).—Particulars of registered mortgages and charges:—Date of covering deed by which security is created or defined, June 30th, 1898, as modified by a deed dated October 6th, 1898; amount secured by whole series, one-half the subscribed capital for the time being; date of resolution creating series of debentures, June 16th, 1898; property charged, the undertaking of the company and all its property whatsoever and wheresoever, both present and future, including uncalled capital for the time being; trustees for stockholders, Electric and General Investment Company, Limited, 1—2, Great Winchester Street, E.C.; date of present issue, July 11th, 1901; amount of present issue, £160,000 in 16 debentures of £1,000 each; amount previously issued of same series, £600,000.

Crompton & Co., Limited (27,200).—This company's annual return was filed on August 30th, when 85,000 shares were taken up out of a nominal capital of £300,000 in 100,000 shares of £3 each. £3 per share has been called up on 52,000, and £2 10s. per share on 31,000 shares, resulting in the receipt of £235,000 5s., including £1,624 paid in advance. £123 15s. remains in arrears. £6,000 considered as paid on 2,000 shares. No mortgages or charges.

United River Plate Telephone Company, Limited (23,651).—This company's annual return was filed on July 19th, when 40,000 preference and 58,000 ordinary shares were taken up out of a nominal capital of £500,000 in 40,000 preference and 60,000 ordinary shares of £5 each. £5 per share has been called up on 40,000 preference and 42,000 ordinary shares, resulting in the receipt of £410,000. £80,000 considered as paid on 16,000 ordinary shares. Mortgages and charges, £179,947.

SUPPLY STATION ACCOUNTS.

Cardiff Corporation Electricity Accounts.

The corner has at last been turned, and the accounts of last year just issued contain the satisfactory result that all charges have been met, a change in the history of the Cardiff Corporation undertaking upon which we must congratulate Mr. Arthur Ellis, the electrical engineer for the lighting and tramways. No doubt this would have been possible some years ago had the price been maintained, but the evident desire was to court popularity by cutting the selling rate, a propensity indulged in without much attention having been apparently paid to the inevitable result.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£85,718	**£101,286**	£15,568
Number of units sold	511,300	**688,549**	177,249
No. of lamps connected.. ...	27,250	—	—
Maximum load in KW.	495	**729**	234
Gross revenue	£8,513	**£11,554**	£3,041
Gross expenditure...	£6,573	**£7,388**	£815
Gross profit	£1,940	**£4,166**	£2,226
Average price per unit sold ...	3·92d.	**3·95d.**	+·03d.

The revenue has been maintained at just under 4d. per unit, and additional sales have brought up the output to over two-thirds of a million units, yielding more than £3,000 greater revenue. That the possibilities of fostering and pushing the business in a busy centre like Cardiff are receiving attention is indicated by the changes, and we look for material improvement in future revenue statements.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£8,348	3·92d.	**£11,341**	3·95d.	+·03d.
Meter rents	164	·08d.	**213**	·08d.	·00d.
Sale of lamps, &c.	—	—	—	—	—
Other receipts	1	·00d.	—	—	—
Gross revenue ...	£8,513	4·00d.	**£11,554**	4·03d.	+·03d.

We now come to the costs which contain the explanation of the improvement in position. Economies have been effected all round, with the one solitary exception of fuel, wherein a small upward alteration is shown, but quite trivial with the lessened costs. Wages, repairs and establishment charges have been reduced in the gross, the saving in these items being no less than £478, notwithstanding a larger output. The reduction of the total costs by ½d. to nearly 2½d. per unit, may therefore be credited to the engineering management.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal	£1,721	·81d.	£2,538	**·89d.**	+·08d.
Oil, waste, water and engine room stores.	322	·15d.	395	**·14d.**	—·01d.
Salaries and wages incurred in generation and distribution, and in street lighting.	1,734	·81d.	1,502	**·52 .**	—·29d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,100	·52d.	949	**·33d.**	—·19d.
Works costs ...	£4,877	2·29d.	£5,384	**1·88d.**	—·41d.
Rent, rates and taxes ..	371	·17d.	665	**·23d.**	+·06d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	797	·37d.	887	**·31d.**	—·06d.
Establishment charges, stationery and printing, law charges and insurance	474	·22d.	379	**·13d.**	—·09d.
Other expenses, certifying meter, stamp duty, &c.	54	·03d.	73	**·03d.**	·00d.
Total costs ...	£6,573	3·08d.	£7,388	**2·58d.**	—·50d.

With gross revenue improved by £3,041, and an increased expenditure of only £815, the extra £422 required by financial charges have been readily provided out of the additional gross profit of £2,226. The sum of £1,804 left over as difference between the two years analysed below has sufficed to wipe out what in 1899 was a loss of £1,794, and for the first time a surplus is shown; although only £10, it marks the inauguration of a state of affairs at Cardiff which we consider should be more than maintained in spite of increasing capital expenditure.

Profit Statement.

	1899.	1900.
Interest on loans	£2,715	£2,825
Sinking fund for repayments	1,019	1,331
Net profit carried to general rate account	—337	—
Net profit carried forward	—1,457	+10
Gross profit	£1,940	£4,166

CITY NOTES.

Johnson-Lundell Report.

The report of the Johnson-Lundell Electric Traction Company, Limited, just issued, is not a very reassuring document. The adverse balance of £4,927 on the profit and loss account is not altogether to be wondered at, since, in the first year, expenses have to be incurred, whilst the revenue is necessarily uncertain. As, however, only £15,000 of the capital remains in hand, and the amount already expended on plant and machinery is but £727, it is not easy to see how dividends are to be earned on the capital of £219,000. Doubtless further information will be forthcoming at the meeting to supplement the apologetic explanations of the report and give the shareholders some indication of the profitable sources of income. Failing such indications, the shareholders might perhaps consider whether it were wise to proceed with the investment of the small remaining capital in manufacturing plant.

British Aluminium Company.

The report for the year ended December 31st states that the profits were £3,619 less than the profit made the previous year, the difference being accounted for mostly by the great increase in the price of coal and other materials used at the Larne and Greenock factories. This falling off is after rectifying an error which was made in reckoning the stocks at the end of the year 1899, and which was only found out recently in preparing the accounts which are now submitted. Owing to this mistake the profit made in 1899 was overstated by £4,620 in the accounts for that year. The carbide account shows that an extraordinary expenditure of £3,142 has been incurred, arising chiefly from delay in the delivery, starting, and operating the requisite new machinery and furnaces. While the

directors consider it would be in order to place a considerable portion of this sum to capital account, they recommend that it be provided for out of the profits of the year, and that the expenses in connection with the French Exhibition be treated in the same manner. The directors have also written off considerable sums by way of depreciation and otherwise from various accounts. Under these circumstances the directors regret that it is impossible to pay any further instalment this year towards the dividend on the 7 per cent. cumulative preference shares.

Electric Tramways Construction and Maintenance Company.

We are indebted to the London financial papers for the information that, on 20th inst., a "large company of gentlemen interested in electric traction" were the guests at a dinner of the directors of the Electric Tramways Construction and Maintenance Company at the Hotel Cecil. Sir J. Kenneth D. Mackenzie presided.

In response to the toast "Success to the Company," the Chairman announced that the directors had determined to pay a dividend of 6 per cent., with a bonus of 14d. per share, making altogether a dividend at the rate of 12 per cent. He said that the company had many miles of tramway schemes in hand, for some of which they had already obtained Acts of Parliament or orders under the Light Railways Acts, and the others were in course of being agreed to by the various municipal and urban authorities. The four great schemes they had in hand were the Lancashire Trunk Electric Tramways, the Yorkshire County Electric Tramways, the Nottinghamshire Electric Tramways, and the City and East London Suburban Electric Railway scheme.

It may be interesting to state here that the company was registered on December 8th, 1886, and its original capital was £250,000 in £1 shares. This was increased to £350,000 by the creation of 100,000 6 per cent. preference shares of £1 each in September, 1901. The directors are Col. J. Harris, 1, Regent's Park Terrace, N.W., chairman; H. G. Thomas, 36, Greenwood Road, Hackney; G. Hunter, Artillery Mansions, Victoria Street, S.W.; E. Rawlings, 16, Victoria Street, S.W. The registered office is given as Albany Buildings, 47, Victoria Street, Westminster, S.W. 55,007 shares were taken up at date of last return (December 31st, 1900).

Willans & Robinson, Limited.

The half-yearly report to be submitted at the meeting to be held at Cannon Street, London, at 2.45 p.m., on October 2nd, reads as follows:—

The accounts for the half-year ended June 29th, 1901, are submitted herewith. After writing off as depreciation from plant, &c., the sum of £5,614 4s. 2d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £7,412 6s. 6d. brought forward) is £34,089 15s. 6d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, amounting in all to £18,682 16s. 3d. The amount payable to the original directors, in accordance with the articles of association, is £3,449 18s. 2d., leaving an available balance of £11,957 1s. 1d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3,500 to the reserve fund, leaving a balance of £6,457 1s. 1d. to be carried forward. In accordance with the authority conferred upon the directors at the last general meeting, 16,666 preference shares of £5 each, and 16,666 ordinary shares of £5 each were offered to the shareholders, *pro rata*, in April last, at £6 and £8 per share respectively. The shares were placed without difficulty, those not taken up by the allottees being largely over-applied for by other shareholders in the company. On December 31st, 1900, the balance of the premiums on shares account stood at £27,440 2s. 4d. Further premiums to the extent of £49,968 have been received during the half-year, and the directors have availed themselves of the opportunity to write off, at one operation, the whole of the goodwill, which since the formation of the present company has stood at £37,879 14s. 11d. They have also written off the whole of the patents account, standing at £3,335 15s. 10d.; a small balance in the Paris Exhibition account, amounting to £171 18s. 10d.; and the expenses of the last issue of shares, £1,028 17s. 11d., which includes £625 for stamp duty. They have also carried to the reserve fund the sum of £25,000, which has been favourably invested at the low prices recently prevailing, and there still remains a balance of £3,991 14s. 10d. to carry forward to the next half-year. The directors are glad to say that the Admiralty has ordered another of the new armoured cruisers of 22,000 H.P. (the *Berwick*) to be fitted with Niclausse boilers by the company's licensees, and they look forward with confidence to the time, now fast approaching, when the company will be able to undertake such work for itself. The use of the Niclausse boiler in foreign navies is rapidly extending, and the directors cannot but believe that its remarkable advantages will be recognised by the British Admiralty when the ships now ordered to be fitted have been tested at sea. The directors regret to announce the loss to the company of the valuable services of their colleague Lieut.-General Sir Richard Hieram Sankey, K.C.B., R.E., who resigns his directorship, owing to the pressure of other engagements. To fill the vacancy thus occasioned the directors strongly recommend the election of Mr. Arthur Lazenby, who has been in the service of the company since 1890. Mr. A. Lazenby has for some years been charged with an important section of the administrative work, and, in the opinion of the directors, he combines in a marked degree technical and scientific knowledge with a thorough acquaintance with the business of the company. He is the holder of 1,249 shares in the company. The directors propose that an agreement be entered into with Mr. A. Lazenby, binding him to give his exclusive services to the company in the same manner as the present managing directors, and they suggest that his remuneration be a fixed salary of £800 per annum, increasing by periodical increments (subject to re-election) to £1,200, together with 3 per cent. of the profits remaining after 7 per cent. has been earned upon the ordinary shares, as set forth in Article 90 of the articles of association.

The Johnson-Lundell Electric Traction Company.

The report of the directors for the period from April 17th, 1900, to April 30th, 1901, was audited by Messrs. Monkhouse, Stoneham & Co, chartered accountants, whose certificate is appended thereto. The revenue was insufficient to meet all expenses, as will be seen by reference to the accounts, which show a deficiency of £4,927 0s. 1d.; cash in hand and at bank, £15,081 3s. 1d.; sundry debtors, £448 13s. 1d. The major portion of this sum has been collected, and the balance is quite good; calls in arrear, £11,999. This amount has now been reduced, and steps are being taken to collect the residue. Nominally, the company began its existence on April 17th, 1900, but, as a matter of fact, it was not ready for business for many months after. This fact has a very direct bearing upon the apparent inactivity of the company, hence some explanation becomes necessary.

Finances.—Owing to the development of unexpected complications and consequent delays in the transfer of the patents and the preparation of the numerous papers in connection therewith, and also because of the temporary default of some of the underwriters, several months elapsed before the directors felt themselves to be fully warranted in incurring any material expenditure.

Apparatus.—It will be recalled that whereas some of the company's inventions had already been put in marketable form, others had as yet only been incorporated in such experimental form as would suffice to enable experts to pass judgment thereon. It was anticipated that immediate business could be done with the former, while the latter was being commercially standardised. Had this forecast been accurate, the company would long since have been engaged in the work of equipping tramways, &c. Unfortunately, it failed to take into account the difference between English and American engine speeds, and the consequent necessity for restandardising the whole line of generators to conform to English requirements. To facilitate this work of restandardising, Messrs. Holmes and Johnson went to America, and established in New York a drawing office under the personal supervision of Mr. Lundell. At the same time they arranged with the Sprague Electric Company for the manufacture of the several standardised units of apparatus as fast as Mr. Lundell and the drawing office could supply the data therefor. Incidentally an agreement was entered into with the Sprague Company for the temporary supply of apparatus to enable the company to fulfil any contracts it might enter into, pending the establishment of its own works. The work of standardising having now been completed, the drawing-office staff has been transferred to the offices of the company in London, where it is now engaged on the engineering work essential to the proper and effective conduct of the business. The company's inventions form three groups:—(1) The dynamos, or electric generators; (2) The motors and controllers; (3) The tramway surface contact system. As to the dynamos, the royalty account, as shown in the balance-sheet, will give evidence that, in spite of the delay caused by restandardising, a fair beginning has been made in the introduction of this apparatus. It is confidently anticipated that here, as in America, these pioneer installations will greatly develop the popularity of this apparatus. The work of standardising the motors and method of control, though much delayed by the unexpected dynamo work, is now practically complete. Sample equipments of two distinct types of motors are now in England and about ready for formal trial, which has been arranged to take place upon the tramways of the Blackburn Corporation in the presence of consulting engineers and tramway authorities. The third and highest development of the company's type of railway motors is now in process of construction under the supervision of Mr. Lundell, in America. The standardising of the numerous details of the surface contact system was left to be dealt with last. It has, however, now been completed, in so far as it can be in the factory or laboratory, and a special engineer will shortly arrive in England to put the system in practical operation on a commercial scale.

Foreign Patents.—Under encouragement from the Continent, Messrs. Holmes and Johnson paid an early visit to France and Germany to determine whether to immediately negotiate for the sale of the Continental patents, or to postpone such negotiations until proof of value had been established by the company's operations in England. As a result of this visit, your board was satisfied that better terms could be obtained when we were prepared to substantiate our claims by the English operations; subsequently, however, the chairman renewed the negotiations in both France and Germany as regards the dynamos only, effecting in each country an optional agreement determinable by the results obtained from a large dynamo, which each of the option holders are now manufacturing for the purpose of acquiring the essential information at first hand. Looking to the preservation and development of the company's Continental patents, a comprehensive and systematic programme has just been approved by your board, and is being put in force.

General.—The vacancy on the board created by the lamented death of Mr. Arthur Laing has been filled up by the appointment of Mr. Alexander McKay. The directors to retire are Messrs. Webb, Johnson and McKay, who, being eligible, offer themselves for re-election. The retiring auditors, Messrs. Monkhouse, Stoneham & Co., also offer themselves for re-election.

The meeting is to be held at the Holborn Restaurant on Wednesday next, October 2nd, at 12 o'clock.

Calcutta Electric Supply Corporation.—The directors are inviting shareholders to subscribe 10,000 shares of £5 each in order to provide the capital required for erecting and equipping a new generating station in the Alipore District of Calcutta, and for large extensions to the mains, to meet the constantly increasing demands for current. These shares will be issued at £6 per share, or 20s. premium for each £5 share. The shares are offered *pro rata* to the existing members in the proportion of one share for every three shares now held. It is stated that the progress of the company is most satisfactory, and there is every prospect of a large and profitable business.

Stock Exchange Notices. — The Committee has appointed special settling days as under:—Wednesday, October 2nd, Chelsea Electricity Supply Company, Limited, further issue of 10,436 ordinary shares of £5 each, fully paid, Nos. 40,501 to 50,936; and has also ordered the undermentioned securities to be quoted in the Official List:—Calcutta Tramways Company, Limited, further issue of £100,000 4½ per cent. first debenture stock; Chelsea Electricity Supply Company, Limited, further issue of 10,436 ordinary shares of £5 each, fully paid, Nos. 40,501 to 50,936.

Direct Spanish Telegraph Company.—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1901, and payable on October 1st next.

City Meetings.—Yesterday meetings were held in the City as follows:—Electrical Undertakings, Limited, Halifax and Bermudas Cable Company, Direct West India Cable Company. At Preston the meeting of the Electric Railway and Tramway Carriage Works, Limited, was held.

Evered & Co., Limited. — An interim dividend at the rate of 7½ per cent. per annum on the half-year ended June 30th last is payable on the 30th inst. The books are closed till October 2nd.

British Aluminium Company.—Mr. R. W. Wallace, K.C., presided at the meeting of this company, held at Winchester House on Wednesday. The report and accounts were adopted.

Globe Telegraph and Trust Company.—The directors have declared an interim dividend of 1s. 9d. per share on the ordinary shares.

Eastern Extension Telegraph Company.—Interim dividend for quarter ended June 30th, 2s. 6d. per share.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Sept. 20th were £570; corresponding week last year, £499; increase, £71. Total to date, £18,983, corresponding period last year, £17,100; increase, £1,883. Miles of track open, 8¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending September 21st were £1,008; corresponding week last year, £1,045; decrease, £37. Total receipts to date, £16,954; corresponding period last year, £16,895; increase, £59.

Bristol Tramways and Carriage Company.—The receipts for the week ending September 20th were £4,130; corresponding period last year, £3,555; increase, £575.

Central London Railway.—The receipts for the week ending September 21st were £5,873; corresponding week last year, £4,891; increase, £982. Total receipts from July 1st (12 weeks), £68,090. Miles open, 6.

City and South London Railway.—The receipts for the week ending September 22nd were £9,040; corresponding week last year, £1,519; increase, £521. Total from July 1st to date, £22,270; corresponding period last year, £18,047; increase, £4,223. Miles open, 4¾.

Dover Corporation Tramways.—The receipts for the week ending September 21st were £256 9s. 2½d.; corresponding week last year, £285 17s. 10d.; decrease, £29 8s. 7½d. Total to date, £8,400 18s.; corresponding period last year, £7,978 2s. 4½d.; increase, £422 15s. 7½d. Miles of track open, 3. Car miles run, 1901, 5,333; 1900, 5,095. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending September 20th were as follows:—D.U.T. Co., electric cars, £3,686 8s. 4d.; D.S.D. Co., electric cars, £883 8s. 6d.; total, £4,569 16s. 10d.; corresponding period last year—D.U.T. Co., electric cars, £3,687 8s.; ditto, horse cars, £29 9s. 5d.; D.S.D. Co., electric cars, £999 19s.; total, £4,666 16s. 5d.; decrease, £96 19s. 7d.; aggregate to date, £61,360 9s. 0d.; aggregate to date last year, £60,016 1s. 8d.; increase, £1,344 7s. 4d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and two miles by horses, for the corresponding period last year.

Glasgow Corporation Tramways.—For the third week in succession a record in drawings was established. For week ending 21st inst., £13,958 19s. 3d.; compared with £9,813 11s. 3d. for same period last year. This is £250 better than the previous record. Since commencement of financial year, June 1st, 1901, £201,393 8s. 8d., has been drawn, compared with £153,627 0s. 9d. for same period last year.

Liverpool Corporation Tramways.—Fortnight ended September 14th, increase in receipts, £1,347 5s. 10d.; in the mileage of 90,453, and in the number of passengers carried, of 622,992, upon the returns for the corresponding fortnight last year.

Liverpool Overhead Railway.—The receipts for the week ending Sept. 22nd were £1,565; corresponding week last year, £1,789; decrease, £224. Total from July 1st to date, £20,531; corresponding period last year, £20,995; decrease £464. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

NOTWITHSTANDING the cheapness of money, which is still the chief characteristic of Lombard Street, the general stock markets are suffering from a spasm of weakness for which a variety of events is responsible. New issues in the Colonial loan market are holding down the quotation of consols and gilt-edged investments generally; a severe fall in the price of copper—which should be good for the telegraph and electrical markets—has shaken at least two of the mining departments somewhat sharply, while a disappointing report from the great Armstrong firm is keeping industrial shares quiet. Business is inclined to be erratic, good one day, and bad the next; but its quietude is reflected in the fact that our price lists exhibit less than a dozen changes as regards the shares dealt in by the London market.

Although the flatness of copper should prove of decided advantage, as we have observed, to the electricity supply and the telegraph markets, neither of those departments has responded to what is probably a merely temporary movement of the metal. Should the fall continue there will be good reason for hoping that expenditure may be seen curtailed in the companies' balance-sheets, but so far the copper *débâcle* passes unnoticed by the two sections mentioned. Notting Hill shares have hardened, and there is generally a firm tone in the market, despite of general weakness of investment divisions round the Stock Exchange. Chelsea Ordinary are a fraction easier at 5½, owing to the fact that the special settlement for the latest-issued shares of this class will take place next Wednesday.

Without any recordable change having taken place in the price, there is a disposition to buy City of London Electrics, now standing at 8¾. A general idea gains ground that the company will declare a 4 per cent. dividend, as it did last year, and it is stated that the differences between the Corporation of London and the City Electric Company have now been arranged. This is the market gossip to account for the buying of Citys that is quietly taking place. On the other hand, the Charing Cross and City is going ahead within the one square mile at a very enterprising pace. City of London 5 per cent. Debenture stock is a shade harder.

The telegraph division is affected to some extent by the all-round droopiness of the other markets. The weakness is very slight, however, the principal change being a fall of 10s. per cent. in Anglo "A" stock, the swing of whose pendulum keeps the price pretty consistently between 10 and 11½. No change has taken place in the Preferred and Ordinary varieties. Eastern Extension 4 per cent. Debenture is a point lower, this being the only change that has taken place in the Eastern group. There is but little doing in this section at present. Globe shares are irregular, the Ordinary and Preference being 5s. up and down respectively. The Ordinary still possess some scope for a further improvement, and the regular quarterly dividend is declared this week. Western Telegraph Debenture stocks of both classes are somewhat better.

National Telephones have again hardened to 4 and the Third Preference to 4⅞. It is confidently stated in the market that there are some operators who know the terms which have been come to by the Government and the company, but that no such knowledge has been vouchsafed to the Stock Exchange. Other telephone issues remain quietly unaltered.

The firmness of British Electric Traction shares is maintained, and last Tuesday's sad accident at Shepherd's Bush has not affected London United Tramways 4 per cent. Debenture stock, which is quoted at 106. Calcutta Trams are supported at about 11¾, and there is a half-hope that this unfortunate concern has at last turned the corner of its ill-luck. The returns for the past quarter certainly encourage the new, although we should hesitate to recommend the shares for investment. Buenos Ayres and Belgrano Debenture stocks are inclined to be harder, the 5 per cent. at 105½, and the second Debenture at par. Anglo-Argentine Permanent 6 per cent. Debenture stock can be sold at 126, or perhaps a little better. There is no market for the shares of the much-advertised Electric Tramways Construction and Maintenance Company. We may mention in passing that it was this concern which so lavishly distributed prospectuses of the notorious Blackpool Electric Tramways, offering the large commission of 2s. 6d. per share upon allotments resulting from applications that bore a broker's stamp.

Electric railway descriptions are a trifle dull, but the only noticeable fall is one of a point in Waterloo and City stock. Mersey Ordinary shares, of £20 each fully paid, stand at a sovereign, the decision to electrify the line not having caused any keen demand for them so far. Great Northern and City Preferred Ordinary are harder, and shares changed hands at 8 7/16 in the earlier part of the week. Metropolitan stock at 78 and District at 29¼ are both dull, and it is high time that someone should be getting impatient besides the long-suffering stockholders in both concerns.

The Willans & Robinson report, showing a profit of £26,700, as compared with £26,200 for the corresponding period, produced a little disappointment, but the shareholders ought rather to congratulate themselves upon the result, and to take their 10 per cent. with gratitude. The Ordinary shares are now 10½, the Preference 6¾, and the 4¼ per cent. first mortgage Debenture stock stands at 106. There is no change of importance in the manufacturing list this week, with the exception of a 10s. rise in India-rubber shares, which has left the price at 22½. The strength of the shares is attributed to the rapid extension of the telegraph industry in all parts of the world, of which the latest evidence is an American scheme for a line linking California with the Philippines.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Sept. 18th.	Closing Quotations Sept. 25th.	Business done during week ended Sept. 25th, 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	78 — 83	78 — 83	...	...
822,700£	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	53 — 56	53 — 56	54⅜	53½
3,088,540£	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	98 —100	98 —100	99½	98⅜
3,088,540£	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	10⅜— 11¼	10¼— 10⅜	10 1/16	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185	175 —185	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	102½	101½
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104 %	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	11	...
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	142 —147	142 —147	145	...
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	96 — 99	96½	96
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	113 —116	116	...
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14 7/16	14 3/16
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	115 —120	114 —119	114	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼ %	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104 %	101 —104 %	...	...
180,227	Globe Telegraph and Trust	10	5½%	5¼%	5¼%	10⅜— 11½	11 — 11¼	11½	11
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	14⅜— 15¼	15 3/16	14⅞
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	...	...
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	41 — 45	41 — 45	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	102 —105	102 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅝— 1	⅝— 1	...	
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅝— 3⅞	3⅞— 4⅛	4	3 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	13	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝— 4⅞	4⅝— 5	4 13/16	4⅝
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	...	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	129	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½	...	...
40,006	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5½	4⅜— 5½	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102	99 —102	100⅛	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14¼— 14⅜	14¼— 14⅜	14 1/16	14⅛
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	102 —105	103 —106	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	103 —106	105	...
88,321	West India and Panama Telegraph	10	2 %	8%	...	¼— ½	¼— ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5 — 6	5 — 6	5¼	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3 — 5	3 — 5	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104	101 —104 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅜— 8¼	7⅜— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8¼— 8⅜	8¼— 8⅜	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5½— 6	5½— 5¾	5 9/16	5⅜
150,000£	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	0 %	8 — 9	8 — 9	8½	8⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½— 12½	11½— 12½	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —125	121 —126	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
200,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	103 —106	103 —106	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5⅜— 6¼	5⅜— 6¼	6	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	104 —107	104 —107	105	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14	13 — 14	13¼	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	112 —115	112 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15½— 16½	15⅝	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000£	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	97 —100	97 —100	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 3	2 — 3	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½%	12 — 13	12 — 13	12½	12⅛

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Sept. 18th.	Closing Quotation Sept. 25th.	Business done week ended Sept. 25th, 1901. Highest.	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	14 — 15	14 — 15	14 1/16	14 3/8
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11 3/4 — 12 1/4	11 3/4 — 12 1/4	12 1/4	12
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	123 —126	123 —126	124 1/2	12[illegible] 1/2
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	..	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	.	5 1/4 — 5 3/4	5 1/4 — 5 3/4	5 1/2	...
50,000	¶Browett, Lindley & Co. (1893), Ord.	£1	...	...	8 %	7/8 — 1	7/8 — 1	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	...	6 %	1 1/16 — 1 1/16	1 1/16 — 1 1/16	...	...
90,000	Brush Elecl. Engine., Ord., 1 to 90,000	2	5 %	6 %	...	1 1/2 — 1 3/4	1 1/2 — 1 3/4	1	...
90,000	Do. do Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2 1/4	2 — 2 1/4	2 1/16	...
125,000*l*	Do. do. 4 1/2 % Perp. Deb. Stock	Stock	...	...	...	102 —105	102 —105	...	...
108,710*l*	Do. do. 4 1/2 % Perp. 2nd Deb. Stock ...	Stock	...	...	..	99 —102	99 —102	...	..
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	15 — 16	15 — 16	15 3/8	15 1/8
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5 3/8 — 6 1/4	5 3/8 — 6 1/4	6 1/16	6
90,000*l*	Do. do. 4 1/2 % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	110 —114	110 —114	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	102 — 105	102 — 105	104	102 1/2
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 — 108	105 — 108	106 3/8	105 1/2
440,100	Do. do. Def. do.	Stock	...	...	...	98 — 101	98 — 101	99 3/8	...
855,000	City and South London Railway	Stock	2 1/8 %	1 7/8 %	1 1/8 %	51 — 54	51 — 54	52	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	5 — 5 1/2	5 — 5 1/2	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7 1/2 %	8 %	3 1/2 — 3 3/4	3 1/2 — 3 3/4	...	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2 1/2 %	1/4 — 1/2	1/4 — 1/2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2 1/2 %	1 1/2 — 2 1/2	1 1/2 — 2 1/2	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	85 — 90	85 — 90	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1 3/8 — 2 1/4	1 3/8 — 2 1/4	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2 1/4 — 3 3/4	2 1/4 — 2 3/4	2 1/16	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102	98 —102	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9 3/8 — 10 1/4	9 3/8 — 10 1/4	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 —102	99 — 102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16 1/2 — 17 1/2	16 1/2 — 17 1/2	17 1/8	17
35,000	Do. do. do. 4 1/2 % Pref.	5	...	4 1/2 %	4 1/2 %	5 1/2 — 6	5 1/2 — 6	...	...
50,000*l*	Do. do. do. 4 1/2 Mort. Deb. Stock...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 1/2 — 22 1/2	22 — 23	22 3/8	22 1/4
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	100 —103 xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3 1/2 %	3 3/4 %	3 1/4 %	7 — 7 1/8	6 7/8 — 7	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	12 3/8 — 13	12 3/8 — 13	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	— —	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17 1/2 %	38 — 42	38 — 42	40 1/2	39
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10 1/2 — 11 1/2	10 1/2 — 11 1/2	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5 3/4 — 6 1/4	5 3/4 — 6 1/4	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	92 — 95	91 — 94	92 3/4	92

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 2/—4/-
National Electric Free Wiring, 17/6 paid, 1/2—3/4.
* From Birmingham Share List.
¶ From Manchester Share List.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15 1/2—16.
Do. do. Pref. (£10 pd.), 10 1/2—10 3/4.
*T. Parker, £10 (fully paid), 16 1/2.

Bank rate of discount 3 per cent. (June 13th, 1901).

MARKET QUOTATIONS, Wednesday, September 25th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a " "	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a " (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£22	..
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8 1/2d.	8 1/2d.	..
a " Caustic (75/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£25	£25	..
a Shellac	per cwt.	80/-	80/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a Bichromate, casks ..	per lb.	2 3/4d.	2 3/4d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b " Wire, in ton lots	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7 1/2d.	7 1/2d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
" " (solid drawn) ..	per lb.	8 1/4d.	8 1/4d.	..
" Wire, basis	per lb.	7 1/2d.	7 1/2d.	..
Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c " " (solid drawn) ..	per lb.	10 1/2d.	10 1/2d.	..
g Copper Bars (best selected) ..	per ton	£82	£82 to £83	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£82	£82 to £83	..
g " Rod	per ton	£82	£82 to £83	..
e " (Elecirolytic) Bars ..	per ton	£83	£82	..
e " " Sheets ..	per ton	£90	£90	..
e " " Rod ..	per ton	£84	£84	..
e " " H.C. Wire	per lb.	9 3/4d.	9 3/4d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	8/8 1/2 to 8/9	8/8 1/2 to 8/9	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants) ..	per ton	45/9	45/8 1/2	1/2d. inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	50/- to 52/6	50/- to 52/6	..
i " Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£12 5 to £12 7 6	£12 5 to £12 7 6	..
g " " Sheet	per ton	£13 5	£13 5	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0 1/2 to 1/8	1/0 1/2 to 1/8	..
p " rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " " strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10 1/2d. to 1/0 1/2	10 1/2d. to 1/0 1/2	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i " " in bars		£58	£58	..
g Tin, block	per ton	£115 10 to £116 10	£116 10 to £117 10	£1 dec.
g " foil	per lb.	1/6	1/6	..
n " wire, Nos. 1 to 16	per lb.	1 8	1/9	1d. dec.
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	..	..
j " 6 tea. Flax	per lb.	5 2d.	..	..
j " 3 ply 10 lbs. Russian ..	per lb.	4 1/2d.	..	..
j " 10 lbs. Russian, single ..	per lb.	4 3/4d.	..	..
j " 180 lbs. Jute rove	per ton	£10 7 6	..	..
k Zinc, Sh't. (Vielle Montagne ord.)	per ton	£22 10	£23 10	..

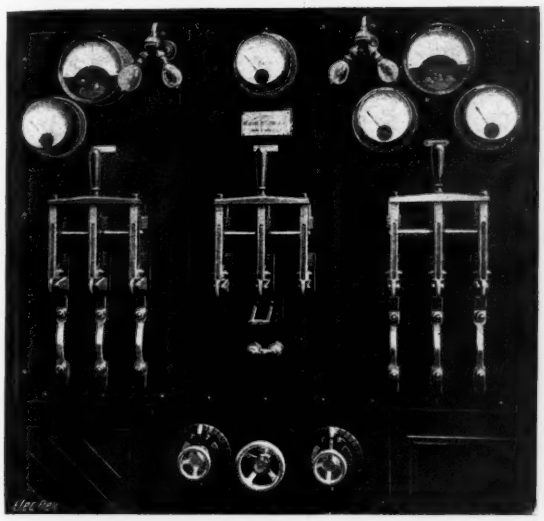
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakespeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Rolling & Tower *j* Messrs. Walter H. Hindley & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

A THREE-PHASE COLLIERY INSTALLATION.

OF the many and diverse uses to which the rotary current can be put, its application to colliery work stands pre-eminently first; not so much from reasons of economy or convenience, as from the fact that, owing to the absence of commutators, there is no danger of sparking—a fault which even the best direct current machine is liable to develop. For this reason, perhaps, colliery engineers have in the past been more or less suspicious of electrical plant, and



G.E.C. THREE-PHASE SWITCHBOARD.

many have decided to forego its undoubted economy rather than incur a possible risk by its use. However, with the advent of polyphase electrical plant, they can no longer have this excuse. Among the first to recognise the advantages of this system of power transmission were the Denaby and Cadeby Main Collieries, Limited, for whom the General Electric Company, Limited, have recently installed a complete three-phase power station and haulage scheme.

Situated in the neighbourhood of Conisbro', Yorkshire, in quite a rural district, this extension of the property of the company is a comparatively new one, the Cadeby shaft having been commenced only 12 years ago. It is one of the deepest shafts in the country, measuring 750 odd yards from mouth to workings. The dip between the uptake and the downtake is 37 ft., the motor haulage gear being situated near the foot of the uptake. At the present moment there are three electrically-driven endless rope haulages in operation, namely, one to the west involving 1,900 yards of rope, with a branch to the centre to a deeper level, working 1,200 yards off a friction drum; one to the east working 1,600 yards of rope; and one central haulage of 420 yards right round. These are all $\frac{3}{4}$-in. ropes. There is also another drive up a gradient of one in six through a stone formation to a pocket at the end of 600 yards. This works by gravity, with the usual band brake control, the ropes being 1 in. in circumference; but it is intended shortly to operate this haulage electrically also. The normal speed of the ropes is 2 miles per hour, and to give an idea of the traffic, it may be stated that on the longest haulage, which involves a dip of 1 in 200, 20 empties and 60 full trucks can be put on at one time.

The power house, which has been specially constructed to take the three-phase generating plant, is a roomy and well lighted brick building, containing two G.E.C.-Musgrave 120-B.H.P. direct-coupled sets.

The engines are of Messrs. Musgrave and Sons' high speed enclosed compound non-condensing type, running at 400 revolutions per minute, with 100 lbs. steam pressure at the stop valve. The cylinders are 11 and 18 in. diameter by 9 in stroke. The governors are on the Pickering principle; the valves are worked by separate eccentrics, so that each valve can be adjusted on its own eccentric. The engines are supplied with steam from the colliery boilers.

The generators are coupled to the engines by means of heavy flywheel couplings, and their bedplates are bolted to the bases of the engines. They are of the G.E.C. six-pole inductor type, and each absorbs 120 B.H.P. on full motor load, the efficiency being 92 per cent., and the frequency 40 cycles. The armature part is star-wound, the voltage of each limb being 230 volts, and of each phase, therefore, 400 volts; the neutral point of each machine is earthed to the frame.

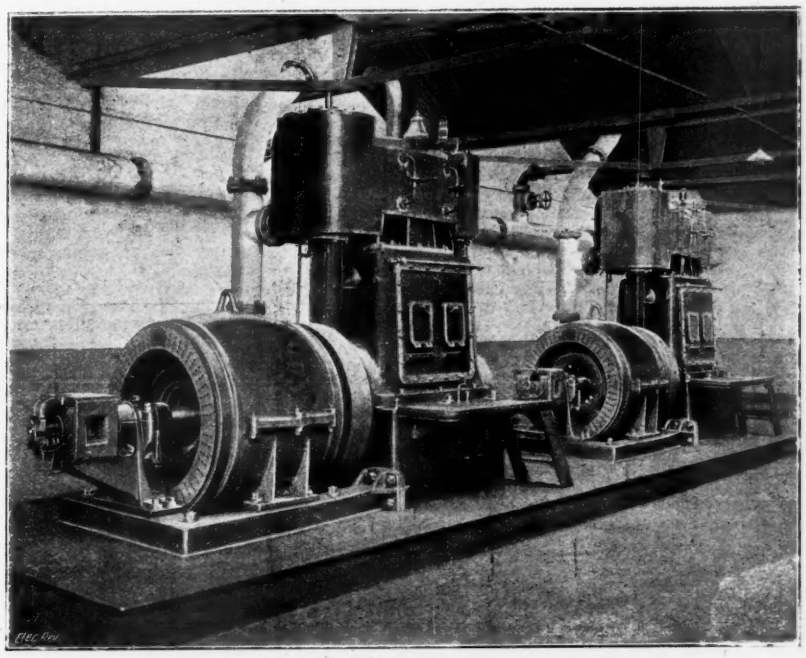
The exciters are fixed on an extension of the generator shafts, and supported by a bracket cast on the main generator bearing. They have box-shaped field magnets. The pressure is 45 volts, and the excitation is regulated by means of resistances in the field circuits of the generators. When running in parallel, these rheostats can be interlocked and worked from a common handle.

A roomy partition of wood has been built out from the wall, and on the front of this the switchboard is mounted; the cables can be reached by means of a lock-up door at the side. The switchboard comprises three enamelled slate panels. The two outer panels are for the generators, and each contains two synchronising lamps, a wattmeter, voltmeter and ammeter, a three-pole "Peel" knife switch for 120 amperes, and three S.P. fuses. The centre panel contains a bus bar voltmeter, two synchronising switches, and a three-pole knife switch as above, to join the bus bars for parallel running. All the instruments are of the "Stanley" direct reading type.

The mains, of which there are two sets, consist of 37/16 three-core lead-covered paper-insulated cables, and are run down the side of the shaft in wood casing; they are calculated for a drop of 5 per cent. on full load.

The haulage plant is situated in the motor house already referred to, and is driven by two G.E.C. induction motors, each capable of developing 110 B.H.P. at 220—380 volts, 40 cycles, when running at 470 revolutions per minute. Each motor drives through double reduction gear a common drum shaft, and is provided with an oil-immersed starting switch and regulator. The gear consists of a 9-in. motor pinion with 14 teeth, working into an intermediate spur wheel 5 ft. 8½ in. in diameter with 107 teeth. The shaft is 6 in. in diameter, and carries a second pinion 22¾ in. in diameter, with 22 teeth, gearing into a large spur wheel 10 ft. 6 in. diameter, with 112 teeth. The drum shaft is 11 in. in diameter, and carries four 9-ft. drums, fitted with improved wedge-driven friction clutches and internal expanding brakes. These are controlled by a hydraulic lever working under a head of 750 yards from the feed tank at the pit head. The gear mentioned above has a total ratio of 1 to 42, which, at the normal speed of the motors, would give 10 revolutions per minute for the drums. This, however, can be slightly exceeded by running the generating plant more quickly. These drums work the three haulages already described; the fourth drum is reserved for the present gravity haulage, which will ultimately be electrically driven.

We believe we are correct in saying that the three-phase haulage



G.E.C. THREE-PHASE INDUCTOR ALTERNATORS AND MUSGRAVE ENGINES.

plant has been working without a hitch, and gives the greatest satisfaction to the colliery company; at any rate, they have given the General Electric Company a further order for three-phase motors to work pumps. One of these is a 50-B.H.P. G.E.C. induction motor, running at 790 revolutions per minute and direct coupled to three Gwynne centrifugal pumps in series. This arrangement is for pumping water from a surface well into the reservoir for the pits, boilers, &c., and it is capable of lifting 18,000 gallons per hour against a head of 200 ft.

Another plant consists of two 20-B.H.P. G.E.C. induction motors running at 1,430 revolutions per minute, each driving a vertical Cameron double-acting 8 in. × 10 in. ram pump through 23 to 1 gearing. These pumps are for supplying the village reservoir from a borehole in the rock, 90 yards deep.

In addition, two direct current 5-B.H.P. G.E.C. motors have been ordered for driving a pug-mill and stone breaker respectively. These are supplied with current from the company's existing lighting plant. They are of the semi-enclosed multipolar type, wound for 110 volts.

Here, then, is an object lesson of what may be done by enterprise and the use of up-to-date systems. We must congratulate the company on their progressiveness, and we are indebted to them for the particulars embodied in this article.

THE INTERNATIONAL ENGINEERING CONGRESS OF 1901.

THE RELATIVE ADVANTAGES OF THREE, TWO, AND SINGLE-PHASE SYSTEMS FOR FEEDING LOW-TENSION NETWORKS.

(Abstract of paper read in Section IX. by Michael B. Field, M.I.E.E., A.M.Inst.C.E.)

In this paper I have merely given expression to my own views on the subject, and have no idea whatever of dogmatically asserting that any one system is the best or the worst for a definite case.

In the case of a large tramway scheme I personally think that any one of the three systems should give excellent results; but while the three-phase is not one bit more complicated (except, perhaps, in theory) than the single-phase, it possesses certain marked advantages from the point of view of prime cost, overall efficiency, and stability of operation. Let us consider the transmission of power from a single central station to a number of feeding centres sufficiently remote to render the adoption of high-tension alternating currents for the transmission an essential; and, further, let us assume that we are not restricted as to the choice of frequency. I do not propose to discuss here the possibility of working the tramway system with alternating current motors. I fully believe that before long this will be possible, but at present it is certainly impracticable. An efficient motor capable of economical speed regulation for city and suburban traffic, giving a large starting torque, and requiring but a single sliding or rolling contact for conveying current into the moving vehicle has yet to be designed.

Anyone acquainted with the Glasgow system will recognise the utter impracticability of working with two overhead conductors at different potentials per track at the very complicated crossings and junctions which occur in the city; or further, the great difficulty and heavy expense of constructing a conduit system for two conductors owing to the enormous number of gas and water mains under the surface of the main thoroughfares; while the very heavy traffic in the same would render a surface contact system unreliable. We have, therefore, no other choice than to assume sub-stations and converters at the feeding centres for transforming the high tension alternating into continuous current at 500 volts.

Transforming Machinery.—The choice of converter lies between (1) Rotary converters combined with static transformers; (2) synchronous, and (3) non-synchronous, motor-generators without transformers.

The relative outputs for the same C^2R loss of a rotary converter if used as a continuous-current generator, or a single-phase, three-phase, four-phase, or six-phase converter respectively, are as follows:—

D.C. generator.	Single-phase rotary.	Three-phase rotary.	Four phase rotary.	Six-phase rotary.
1·00	·825	1·31	1·61	1·94

The four-phase connections will be employed with the ordinary two-phase transmission system, the three and six-phase rotary connections with the three-phase system, or possibly with a suitable arrangement of transformers with the two-phase system.

Table I. has been taken from Mr. Eborall's paper on "Polyphase Sub-station Machinery," the last column, which refers to the Glasgow 500-KW. rotary, having been added.

Table II. gives costs, efficiency and weight of rotaries, synchronous and non-synchronous motor-generators for 25 cycles, 500-KW. output.

From these figures it is evident that the rotary converter *per se* has the advantage over all other converters.

There is, as regards complication, nothing to choose between a rotary with its transformers and a motor-generator without. Much is talked about surging and hunting of rotaries; almost exactly the same may occur with synchronous motors; but in all well-designed machines of both types, driven from good generators coupled to well-designed engines, this trouble may be considered as practically non-existent.

Table I.

Type of equipment.	Asynchronous motor-generator.	Synchronous motor-generator.	Rotary converters and step-down transformers.	Glasgow rotary.
	KW.	KW.	KW.	KW.
Output of sub-station converter	500	500	500	500
Speed of converter	300	300	300	500
Efficiency { Full load	86%	87%	92%	92·5*
Efficiency { Half „	80%	79%	87·5%	89·5*
Overload capacity for one hour with fixed brushes	25%	25%	75%	50%* Rise of T. = 60° C.
Power-factor { Full load...	91%	100—96% (leading.)	100—96% (leading.)	—
Power-factor { Half „	88%			
Floor space per KW. (sq. ft.)	0·5	0·5	0·45	0·34

* Figures marked thus are guaranteed by contractors only.

Lastly, as regards overload capacity, ease of regulation and manipulation, the rotary converter affords all that can be desired. The Glasgow rotaries, for example, have from the moment they were first started run without trouble of any kind. Perhaps the only trouble we have had at all has been the reversal of the polarity of the rotaries.

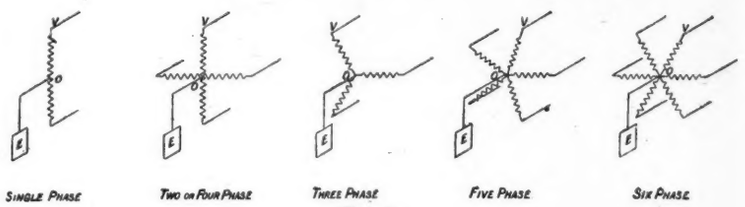


Fig. 1.

Table II.

Type of sub-station converter.		Cost, including all necessary starting gear.	Total weight.	Efficiency of equipment. Full load.	¾ load.	½ load.
		£	Tons.			
3-phase rotary with transformers.	A	2,160	33	91	89·75	86·75
	B	2,560	31	92	90·5	88
	C	2,240	38	93·6	92·6	88·4
2-phase ditto.	A	2,240	34	91	89·75	86·75
	B	2,580	32	92	90·5	88
	C	—	—	—	—	—
3-phase synchronous motor-generator.	A	2,400	42	89·5	88·25	85·25
	B	2,280	44	86·5	85	81·5
	C	2,320	42	90	87	80
2-phase ditto.	A	2,400	42	89·5	88·25	85·25
	B	2,280	44	86·5	85	81·5
	C	2,320	42	90	87	80
Single-phase ditto.	A	2,500	44	88·5	87·25	84·25
	B	2,440	48	85	83	79
	C	—	—	—	—	—
3-phase induction motor-generator.	A	2,680	50	89	87·75	84·75
	B	2,260	44	85·5	84·5	81·5
	C	2,360	43	89	86	80
2-phase ditto.	A	2,680	50	89	87·75	84·75
	B	2,300	45	85	84	81
	C	—	—	—	—	—
Single-phase ditto.	A	3,200	64	85	83·75	81
	B	2,580	52	80	77	72
	C	—	—	—	—	—

N.B.—All the above refer to converter equipments of 500 KW. output at 540 to 550 volts on the D.C. side. Input at 6,500 volts on A.C. side. To each equipment is direct-coupled a negative booster, 600 amps. at 50 volts for rail return cables, *i.e.*, Glasgow Practice, and where necessary a starting motor. A, B, C, refer to different makers.

Cables.—Theoretically the three-phase system should give the best results as regards power that can be transmitted with given weight of copper and with a minimum strain upon the insulation of the system.

Fig. 1 represents systems involving the single, two or four, three, five, and six-phase principles, the neutral point in each case being earthed. Let v be voltage and c current per leg in each system (in the single-phase case the line voltage equals 2 v), then the power

transmitted in the different cases will be represented by $n \, v \, c \cos \phi$, where n = number of legs, and ϕ = angle of lag. The power transmitted per unit weight of copper will be the same in each case, and similarly the maximum potential above earth; but the maximum potential difference existing between any two points in the system (*e.g.*, between the cores of a line cable) is a minimum in the three-phase case. Again, if the neutral point be not earthed, we must consider as the maximum strain on the insulation the voltage above earth of any line-wire or pole if one other become accidentally earthed for an instant; this is again clearly a minimum in the three-phase case.

In comparing the various systems, we can either keep the maximum potential above earth the same in each case—in other words, keep the same strain upon the insulation of generators, &c.; or we can keep the difference of potential between the line conductors, that is, the strain on the insulation of the cables, the same in each case. It does not, however, follow that these two conditions will obtain at the same time.

Table IV. gives a comparison of various cable systems, taking as a basis one mile of three-core cable with earthed neutral, transmitting 1,000 kw. at 6,500 volts (three-phase), the area of each core being 0·15 sq. in. In every case the effective voltage is referred to, not the maximum of the voltage-wave curve.

In the above case the strain on the insulation of generators, transformers, &c., is 3,750 volts, and on the insulation of the cables 6,500 volts.

Cases 2 and 3 represent a single-phase transmission with concentric cables. In this instance it will be essential to work with an earthed outer conductor.

Cases 4 and 5 represent a single-phase transmission with two-core cables, the neutral point being earthed.

Case 6 represents a single-phase transmission with two separate cables and an earthed neutral. Twice the number of cables is required; and the self-induction of the line materially increased.

Cases 7 and 8 represent two-phase transmissions with four-core cables and earthed neutral points. They exactly correspond to Cases 4 and 5, and to Cases 9 and 10.

Case 11 represents the three-phase three-core case where the neutral is not earthed.

This discussion, I think, includes all possible cases, and the basis of comparison is a fair one. The last column of the table giving costs applies to lead-covered paper-insulated cables, and includes the cost of duct laying on the system adopted in Glasgow; the table clearly shows that the advantage certainly lies with the three-phase system.

Personally, I much prefer to have an unearthed system, and to rely on keeping a proper check on the insulation. If concentric cables be employed, it is imperative to earth the outer conductor. I think a three-core cable is the handiest and best.

(To be continued.)

Table IV.

1,000 kw. transmitted one mile through—	Volts between line wires or cores.	Volts per leg of system.	Current per line wire.	Area cross section per line wire.	Total area cross section.	Volts above earth of any line wire, *i.e.*, electrical strain on generators, switch gear, &c.	Volts between cores, *i.e.*, strain on insulation of cable.	Cost per mile laid and jointed, including ducts and drawing in.	
								A.	B.
								£	£
(1) 3-phase, 3-core; earthed neutral point of system	6,500	3,750	89	·15	·45	3,750	6,500	956	1,072
(2) Single-phase concentric; earthed conductor	3,750	—	267	·9	1·8	3,750	3,750	2,244	2,154
(3) Ditto, ditto.	6,500	—	154	·3	·6	6,500	6,500	1,150	1,499
(4) Single-phase, 2-core; earthed neutral ...	6,500	3,250	154	·3	·6	3,250	6,500	1,090	1,175
(5) Ditto, ditto.	7,500	3,750	133	·225	·45	3,750	7,500	968	1,067
(6) Single-phase, two separate cables, outer earthed neutral	7,500	3,750	133	·225	·45	3,750	Strain on insulation 3,750	1,128	1,280
(7) 2-phase, 4-core; earthed neutral	6,500	3,250	77	·15	·6	3,250	6,500	1,132	1,256
(8) Ditto, ditto.	7,500	3,750	66·5	·1125	·45	3,750	7,500	948	1,182
(9) 2-phase, two 2-core cables, earthed neutral	6,500	3,250	77	·15	·6	3,250	6,500	1,540	1,482
(10) Ditto, ditto.	7,500	3,750	66·5	·1125	·45	3,750	7,500	1,352	1,374
(11) 3-phase, 3-core; not earthed	6,500	3,750	89	·15	·45	6,500	6,500	1,144	1,168
(12) Single-phase, 2-core; not earthed ...	6,500	3,250	154	·3	·6	6,500	6,500	1,204	1,284
(13) Single-phase, two separate cables; not earthed	6,500	3,250	154	·3	·6	6,500	6,500	1,420	1,456
(14) 2-phase; 4-core	6,500	3,250	77	·15	·6	6,500	6,500	1,240	1,388
(15) 2-phase; two 2-core	6,500	3,250	77	·15	·6	6,500	6,500	1,692	1,590

The above prices refer only to paper-insulated, lead-covered cables, drawn into cement lined iron ducts (*i.e.*, Glasgow practice). In each case the same power is transmitted, and the loss per mile in kw. is 6·3.

ELECTRICITY SUPPLY METERS OF THE ELECTROLYTIC TYPE.

(Abstract of Paper read by J. R. Dick, M.I.E.E., before Section IX.).

In the evolution of the best supply meter, the type that survives will be the one that combines cheapness with the greatest permanent accuracy. In attempting to solve the problem, much attention has naturally been paid to electrolytic meters, on account of their inherent simplicity.

In all cases of electrolytic decomposition, the amount of electrolyte decomposed per second is directly proportional to the current. In fact, the meter has a natural straight line law of registration.

In spite of these initial advantages, electrolytic meters generally have earned a bad reputation for various reasons, chiefly because they are "messy," and require attention for the renewal of electrodes or electrolyte, and because of the great drop of pressure with the unshunted varieties.

This paper will be devoted to those which are shunted, with special consideration to those which depend on the measurement of the quantity of mercury deposited from a solution of a mercurous salt.

In employing a shunt to an electrolytic cell which has a back E.M.F., some compensating E.M.F. has to be inserted in the cell

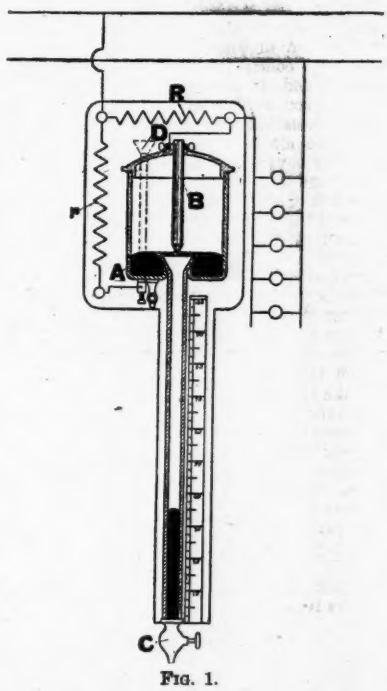
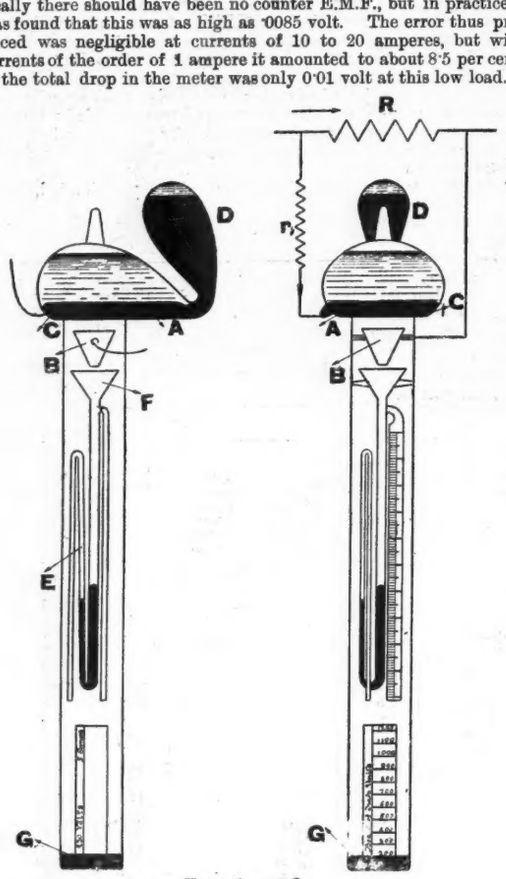


Fig. 1.

circuit in order to obtain a constant linear ratio between the main and the shunt currents.

The shunt circuit detracts from the simplicity of the electrolytic method of registration, and increases the total loss of energy in the meter. To avoid this loss, and the complication of a compensated shunt circuit, it is infinitely preferable to utilise, if possible, an electrolytic cell where no back E.M.F. exists.

The Edison meter, in which were employed two amalgamated plates of pure zinc in zinc sulphate, aimed at this ideal. Theoretically there should have been no counter E.M.F., but in practice it was found that this was as high as ·0085 volt. The error thus produced was negligible at currents of 10 to 20 amperes, but with currents of the order of 1 ampere it amounted to about 8·5 per cent. as the total drop in the meter was only 0·01 volt at this low load.



Figs. 2 and 3.

The correct registration of small currents has assumed a still greater importance since supply pressures of 230 and 250 volts came into general use.

The necessary characteristic of having a low back E.M.F. is common to all meters in which the amount of mercury liberated from a solution is used to measure the quantity of electricity passed through it. The highest accuracy can, therefore, be guaranteed even with very low currents. A variety of forms of such meters have been designed, but most of them suffer from various defects, and have not been generally employed.

The earliest of these is that of McKenna (1892). The reason of mercury being selected was primarily due to the facility with which the volume of the fluid metal deposited could be measured in a graduated vessel.

The illustration in fig. 1 shows the apparatus, which consists of an anode of mercury contained in the pocket, A, the cathode of carbon B, and the electrolyte. The latter is usually mercurous nitrate, as it is one of the most soluble salts of the metal. The monovalent salt has the incidental advantage that, for the same current, twice as much metal is deposited as is liberated from the mercuric salt.

The electrolytic cell is connected across a low resistance shunt, R, inserted in one of the supply mains. A comparatively large resistance, *r*, is put in circuit with the cell itself, so that only a small fraction of the current passes through the electrolyte.

The action of the current is to deposit mercury on the carbon pencil, whence it drops into the graduated tube. By properly calibrating this tube, the meter may be made to read directly the number of units consumed by the installation. The deposited mercury may be drawn off by the stop cock, C, and returned to the anode by the funnel, D.

Although this meter is excellent in principle, it could never be adopted in practice. The first defect to become visible in working would be a deposit of crystals at the anode surface. The electrolyte at this point becomes very rich in mercury, dissolved from the anode; ultimately it gets saturated, and deposits crystals, because there is no provision for agitating the solution and equalising the densities. There is a great increase of resistance due to this production of crystals, and the meter no longer gives accurate results. Further, as the mercury in the trough is dissolved and deposited in the tube, the surface falls below its original level, and the distance from the cathode increases, with a corresponding change in the internal resistance of the cell and an accentuation of the resistance error.

A third practical defect is the method of resetting the meter to zero, which is by drawing off the mercury and replacing it in the anode chamber. In this process dirt is certain to be introduced either into the metal or the solution, which will cause an irregular deposit when the meter next begins to register.

As is well known, too great care cannot be exercised in maintaining the chemical purity of mercury when used for electrolytic purposes.

Anders & Kottgen's meter (1892) is of the same class as McKenna's, and the same effects militate against its successful working.

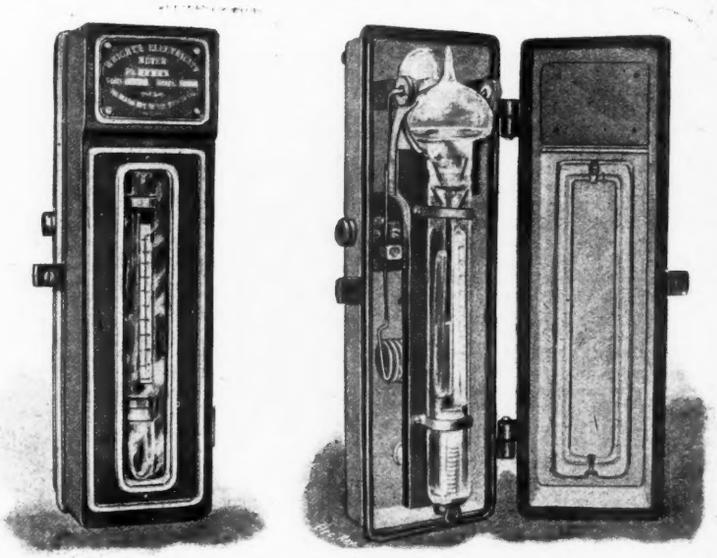
The meter illustrated in figs. 2, 3, 4 and 5, which has been devised by Mr. Arthur Wright, is the outcome of much thought and experiment in this province, and after being subjected to exhaustive tests, has given thoroughly satisfactory results.

The general principle of the meter is the same as already described, *i.e.*, the amount of mercury deposited from a solution of a mercurous salt is employed to measure the quantity of electricity. The various parts of the electrolytic cell are enclosed in a hermetically sealed glass tube. The method of connecting up the meter is similar to McKenna's. The total resistance (including the cell) in the shunt circuit is about 40 ohms, and the maximum current in it is about 0·025 ampere for a meter of 5 amperes capacity. The resistance in the main circuit is of platinoid wire, and has a value of 0·2 ohm. What differentiates it at once from the other types is the change in the relative position of the anode, A, and the cathode, B. The former is now placed *above* instead of *below* the latter. The mercury of the anode is contained in a circular trough, C, which is filled to such a height that the more concentrated solution formed by the electrolytic action falls off the convex surface of the mercury by gravity, and thus automatically mixes the liquid and tends to keep it of a uniform density. The aid of gravity in thus promoting diffusion would soon be ineffective if the mercury of the anode were to sink below the level of the lip of the trough. This is prevented and constancy of level is obtained by the employment of an anode "feeder," D, after the manner of the well-known "bird-fountain." When any portion of the mercury has been electrolysed from the anode and the level sinks to the smallest extent, it is quickly restored to its former height by a slight flow from the anode "feeder," while a corresponding amount of solution replaces the mercury thus withdrawn from the "feeder."

The cathode usually consists of a hollow cone of platinum foil or carbon, arranged concentric with the annular trough forming the anode.

The circulation of the electrolyte above described is reinforced by the cathode, as the lighter liquid produced at its surface tends to rise and replace the dense solution formed at the anode. This interchange of solution goes on continuously, and there is no need for agitation or stirring.

The gravitational effect and the large extent of active anode surface permit of comparatively large currents in the cell before any signs of saturation in the solution become visible. Consequently there is a large factor of safety between the working current density and that causing crystallisation. This factor of safety may be as high as four or five.



Figs. 4 and 5.

To secure accuracy with a shunted meter, it is a *sine qua non* that the resistance of the cell itself should be constant, or nearly so. This is only possible where no change takes place in the areas of the elec-

trode surfaces, or in the distance between the two electrodes, or in the density of the electrolyte.

In the present meter these first two essentials are fulfilled completely by the operation of the "anode" feeder in keeping the surface of the mercury in the trough always at the same height and of the same area, and the third is secured by the automatic circulatory process.

As is seen in fig. 3, the meter is provided with two scales. The first of these is equal to 100 units, and is fixed alongside one of the limbs of the siphon or U-tube E. The mercury that is deposited on the platinum cone drops in the form of minute globules into this tube, which opens out at its upper end into a glass funnel, F, luted on to the main tube so that none of the mercury can escape falling into it and being measured.

When a quantity of mercury calibrated to be equal to 100 units has collected in the right-hand limb, it will stand at a level somewhat higher than the top bend of the siphon tube. This difference of head is sufficient to cause the siphon to come into action, and the whole of the mercury contained in the U-tube to be drawn over and fall into the lower receptacle G. This is graduated in such a manner that one division on its scale is equal to the complete volume of the U-tube. It therefore acts like the "second dial" of a clock-train counting mechanism; in other words, the range of the meter is very much increased, while the sensitiveness of the lower readings is not in the least impaired. A 5-ampere meter furnished with these two "dials" will register conveniently up to 1,200 units. In fact, the range of the meter is only limited by the weight of mercury it is advisable to have in the anode feeder.

A simpler type of meter, having a range of about 250 units, can be made, in which the mercury deposited does not fall into a siphon tube, but into an ordinary tube reading direct in units.

When a full record has been obtained on the meter, it is necessary to reset it. This is done by tilting it up (like a demand indicator) on its hinged terminals, when all the mercury in the lower part of the tube will flow back into the anode chamber. A small hole is left in the glass funnel at the top of the siphon tube for the passage of the mercury. By this simple operation the meter is brought back exactly into its original condition. It is interesting to note

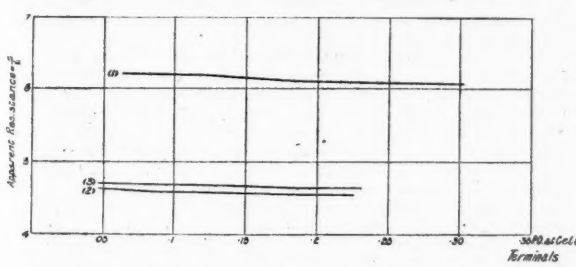


Fig. 6.

that this resetting is required only at long intervals. For a consumer with a 5-ampere demand on 230 volts, 1,200 units would represent at least 1,000 hours all taken at the maximum load. This is equivalent to a year's consumption with 2·75 hours' use per day of the maximum demand. In most cases, therefore, there would be no need to reset the meter oftener than once a year.

The glass tube is hermetically sealed, as the chemical action does not give rise to the production of gas, and consequently there is no internal pressure. As there is no opening to the air, there is no evaporation, no efflorescence, and no deterioration in the quality of the materials. The meter is not affected by atmospheric pressure, and only to a very small extent by external temperature. For this a simple means of compensation is available.

Freezing does not take place, even at a temperature of − 4° C.

(To be continued.)

BRITISH ASSOCIATION, GLASGOW, 1901.

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

By Killingworth Hedges, M.Inst.C.E., M.I.E.E.

(*Abstract. Section G.*)

The last time this subject was brought before this Association was at the Bath meeting in 1888, when the joint discussion of Sections A and G was held; but there has been no official report as to the effect of lightning stroke upon buildings protected by conductors since the Lightning Rod Conference of 1882. Interest in the subject has been again revived, first, by the Electro-Technische Verein of Berlin, who have this year published a set of rules; and secondly, by the establishment in this country of the Lightning Research Committee, organised jointly by the Royal Institute of British Architects and the Surveyors' Institute.

The author compares Continental and American practice, and gives an account of his rearrangement of the system used at St. Paul's Cathedral, where the conductors, erected as recently as 1872, were found to be totally inefficient, both as regards the conductivity of the joints and the resistance of the earth connections. In the plan recommended, both for this installation and for the more recent one at Westminster Abbey, the number of ordinary conductors from air to earth has been greatly increased, and, besides these, horizontal cables are run on the ridges of the roofs and in other prominent positions so as to encircle the building, being interconnected to the vertical conductors wherever they cross one another. The horizontal cables are furnished at intervals with aigrettes, or spikes, which are invisible from the ground level, and are designed to give many points of discharge. At the same time they, in conjunction with the cables, would receive any side flash which might occur should any portion of the building receive a direct stroke of lightning.

The unreliabity of soldered joints for conductors, whether of cable or tape, has led the author to design a special joint box, which can be applied for uniting any portion of the system together in such a manner as to give great mechanical strength as well as good electrical contact; at the same time any box can have points inserted so as to form an aigrette in any desired position.

Owing to the difficulty of sinking an earth plate of sufficient area, on account of old foundations, a special form of tubular earth has been designed which takes up little space and has the advantage that if a suitable moist ground is not obtainable the desired low electrical resistance is attained by leading a tube in connection with the rain-water pipes, so that a portion of the rainfall is diverted to the tubular earth.

The author alludes to the immense amount of damage to property annually occurring which might be prevented if efficient conductors were installed. He mentions that instead of every church having its lightning conductor not 10 per cent. are so provided; and in the case of other public buildings the percentage is not much larger, the reason in the case of the former class of buildings being that a vicar wishing to safeguard his church has usually to pay the cost out of his own pocket.

Architects, as a rule, treat the question of lightning conductors in a very brief manner, and in their specifications seldom say anything as to the way in which they are to be run, or the necessity for good joints and good earth connections.

ON THE CHANGE OF CONDUCTIVITY OF METALLIC PARTICLES UNDER CYCLIC ELECTROMOTIVE VARIATION.

By Prof. Jagadis Chunder Bose, M.A., D.Sc.

(*Abstract. Section A.*)

1. Under the action of electric radiation the conductivity of metallic particles exhibits variation. In the positive class, like iron, there is an increase, and in the negative, like K, &c., a diminution, of conductivity. Each class again falls into two sub-classes: (*a*) sensitive substances which undergo self-recovery; and (*b*) sensitive substances which do not. In the case of self-recovering substances the conductivity distortion varies with the intensity of radiation. Under the continued action of radiation, the distortion attains a maximum, balanced by force of restitution, and on the cessation of radiation there is an elastic self-recovery.

2. The three classes of substances, positive, negative and neutral, may be distinguished by their peculiar characteristic curves.

3. The change produced in the sensitive substance by the action of radiation is not, normally speaking, chemical.

4. The conductivity change is produced, not only by very rapid, but also by comparatively slow electric variation. Generally speaking, all the conductivity variation effects produced by electric radiation can be reproduced by comparatively slow cyclic electromotive variation.

5. These conductivity changes under cyclic electromotive variation may be continuously recorded by means of the conductivity curvograph.

6. Electric conduction in metallic particles sensitive to electric radiation does not obey Ohm's law. The conductivity is not constant and independent of the E.M.F., but varies with it. In the positive class the characteristic curve—in which the ordinates represent the currents, and the abscissæ the E.M.F.—is concave to the axis of the current. The conductivity increases *continuously* with increasing E.M.F. The variation of conductivity in the lower portion of the curve is small, but increases with great rapidity in the upper portion.

7. The curve obtained with strong is steeper than that with feeble initial current.

8. There is found, especially when the initial current is feeble, a critical E.M.F., at which the conductivity change becomes so rapid as to produce an almost abrupt bend in the curve. Stronger initial current appears not only to lower the critical point, but also to mitigate the abruptness of this change.

9. The effect of E.M.F. in modifying the conductivity of the conducting layer is well seen in self-recovering substances. There is a definite conductivity corresponding to a definite E.M.F. As the E.M.F. is increased, the sensitive molecular layer is strained, and a definite increase of conductivity produced. When the increased stress is removed, the corresponding strain also disappears, and there is an elastic recovery of its former molecular and conductive state. Hence, when it is carried through a complete cycle of electromotive variation, with moderate speed, the forward and return curves coincide, and the substance remains at the end of the cycle, in its original molecular condition.

10. This is the case where there is complete recovery on the removal of the stress. With non-recovering substances we find an outstanding residual effect. In a curve taken with cyclic electromotive variation, the forward and return curves do not coincide,

but enclose an area. There is a hysteresis. The larger the range of the electromotive variation the greater is the area enclosed. There is a residual conductivity variation, at the end of the cycle, which may be dissipated by vibration.

THE COMMERCIAL IMPORTANCE OF ALUMINIUM.

By Prof. ERNEST WILSON, M.I.E.E.

(Section G.)

So far as I have ascertained, no paper dealing with the progress in manufacture and general properties of aluminium has been read before the British Association during the last 10 years. During this period enormous progress has been made in the production of aluminium, as can be gathered from the fact that in 1900 no less than 5,000 tons were produced by plant having a combined output of about 25,000 H.P., representing a capital of over £2,000,000 sterling.

Progress in Manufacture.—As far as is known, aluminium exists nowhere uncombined in the metallic state, and its production is essentially a chemical operation. The introduction of the electrolytic process for the production of aluminium marks an epoch in the history of this subject, as at the present time (1901) all aluminium may be said to be produced by this method. The process was patented in 1886-87 by Hall in America, and Héroult in England and France. In 1888 Hall was at work with it on a commercial scale at Pittsburg; in 1891 the plant was removed to New Kensington, and was gradually enlarged to 1,500 H.P., and in 1894 works of 5,000 H.P. were erected at Niagara Falls. In 1890 the Hall process operated by steam power was installed at Patricroft, Lancashire, but the French and Swiss works operated by water power in 1894 ruined the enterprise. About 1897 the machinery at St. Michel passed into the hands of Messrs. Pechiney, and was soon increased to 3,000 H.P., and here aluminium is still being manufactured by the Hall process. At Neuhausen about 4,000 H.P. is obtained from the Rhine, at Rheinfelden about 2,000 H.P., while about 3,000 H.P. are used by the Société Electro-Metallurgique Française, of La Praz, near Modane. In 1895 the British Aluminium Company was founded to mine bauxite and manufacture alumina in Ireland, to reduce the aluminium at Foyers, and to refine and work up the metal at Milton, in Staffordshire. By the end of 1899 plant of 7,000 H.P. had been installed at Foyers; some of it, however, being employed for the production of calcium carbide. In order to meet the demands of the Pittsburg Reduction Company, and as an indication of what is expected of aluminium, it may be mentioned that the Niagara Falls Company are installing two new turbines. Space does not permit of further description; but the above remarks are sufficient to show how rapidly the electrolytic process has been developed.

The Electrolytic Cell.—A short description of the Héroult cell which is used at Foyers may be here given. It consists of a square iron or steel box lined with carbon, at the bottom of which is a cast-iron plate connected with the negative pole of the dynamo. The positive pole of the dynamo is connected to a bundle of carbon rods suspended from overhead and capable of vertical adjustment. The cell is filled with cryolite, which becomes molten by the passage of the electric current, and then the powdered alumina is fed in continuously as long as the operation proceeds. The potential difference between the terminals of each cell is from 3 to 5 volts, and the current overcomes the chemical affinity of the aluminium oxide, besides heating the electrolyte. The operation is essentially a dissociation of alumina into aluminium, which collects at the cathode or negative plate, whilst the oxygen, which is evolved at the anode or positive pole, combines to form carbon monoxide and dioxide. The current density is about 700 amperes per square foot of cathode, and the working temperature varies from 750° to 850° C. The actual yield is 1 lb. of aluminium per one electrical horse-power-hour.

Alloys.—Aluminium can combine to produce an enormous number of alloys, some of which, containing 1 to 2 per cent. of other metals, combine the lightness of aluminium with greater hardness and strength. Other alloys containing from 90 to 99 per cent. of other metals exhibit properties of those metals much improved for certain purposes. Much as has been already done, much more remains, and the alloy producing property of aluminium opens up a vast field for research. It must be remembered that electrolytic aluminium has only been known during the last few years, and now that its purity can be controlled on a large scale, consistent results may be obtained. The purest aluminium obtained commercially contains traces of iron and silicon, giving about 99·6 per cent. of aluminium in the finished product. All aluminium may be said therefore to be used in the alloyed state. The subject naturally divides itself into two branches: (1) light aluminium alloys; (2) heavy aluminium alloys.

Light Alloys. — The colour of commercially pure aluminium depends upon the temperature at which the metal has been treated. Cast in chill moulds and cooled quickly, or cast in green sand at a low temperature, the metal has a bright white colour nearly like that of silver. When cast too hot in dry sand, the colour is grey like lead or bluish like zinc. The fracture grain differs considerably according to the method of casting, cooling or working. When drawn, rolled or forged, the metal shows a silky grain. The specific gravity of commercially pure aluminium varies at atmospheric temperature from 2·56 when cast in sand to 2·71 when hammered or drawn. Compared with other metals, its specific gravity is as follows:—

∞	Aluminium...	1
∞	Zinc	2·7
	Tin	2·76
∞	Cast-iron	2·91
∞	Nickel	3·37
	Copper	3·37
∞	Silver	3·98
	Lead	4·30
	Gold	7·31
	Platinum	8·15

The extraordinary lightness of aluminium is one of its most striking characteristics. Since the weight of a given volume of a metal may govern its financial value, copper being 3·37 times as heavy as aluminium, it follows that whenever aluminium costs less than 3·37 times copper, it is cheaper volume for volume. The prices of metals fluctuate very much, but taking copper at £70 and aluminium at £130 per ton, we see that aluminium is considerably cheaper than copper. It remains to be seen in what manner the volumes of different metals have to be related for specific purposes.

Conductor of Electricity.—The use of aluminium as a conductor of electricity is engaging the attention of engineers very much at the present time, and already large quantities of it have been installed. A number of different alloys of aluminium have been tested at King's College, London, for the British Aluminium Company, and it is the intention of the author to publish these in full later, but a general reference may be made. Aluminium (containing ·31 per cent. Fe and ·14 per cent. Si) has a specific resistance of

$$\left\{\begin{matrix} 2{\cdot}59 \times 10^{-6} \text{ legal ohms at } 0^\circ \text{ C.} \\ 2{\cdot}762 \times 10^{-6} \quad \text{,,} \quad \text{,,} \quad 15^\circ \text{ C.} \end{matrix}\right\},$$

a temperature coefficient ·00393 and linear coefficient of expansion ·000023 between 16° and 100° C. Weight for weight the conductivity of this aluminium is double that of copper, or, for equal conductivity, half the weight of aluminium would be required; or for a given length of conductor carrying the same electric current with the same loss, that is, the same fall of potential, the relative weights would be as 1 of copper to ½ of aluminium. This necessarily involves a great saving in transport, and there is the additional advantage that fewer and lighter poles are required for erecting overhead conductors.

Taking the specific resistance of aluminium at 2·76 and copper at $1{\cdot}696 \times 10^{-6}$ ohms (Matthiessen's standard) at 15° C., the diameter of the aluminium wire will be 1·27 that of the copper. For equal conductivity it follows that the insulation on covered aluminium wires will be greater, but the covered wire will be still less in weight than the copper. It is as a bare conductor for long-distance transmission that aluminium has been largely used, and it is therefore necessary to consider the tensile properties and change in length due to change in temperature. The commercially pure aluminium alluded to above has, when in the form of wire, ·126 in. (3·2 millimetres) in diameter, a breaking load of 28,200 lbs. (12·6 tons) per sq. in., a limit of elasticity 19,376 lbs. (8·65 tons) per sq. in., and percentage extension ·19 within the limits of elasticity with an applied force of 16,250 lbs. (7·2 tons) per sq. in. Alloying this aluminium with copper, zinc, nickel, or iron in varying proportions to the extent of about 2 per cent. increases the tensile strength at the expense of conductivity. It is, therefore, important to know what the tensile properties have to be in particular cases. The Standard Electric Company of California in their 43 miles of transmission line employ aluminium wire ·294 in. in diameter having a resistance per mile of 1·008 ohms at 25° C., and this is stated to have a conductivity of 59·9 per cent. of copper. The breaking load is 22,800 lbs. (10·1 tons) per sq. in. No limit of elasticity is given, but it is stated that at 14,500 to 17,000 lbs. per sq. in. there is a marked increase in the permanent set, which was taken to indicate the limits of safe working load. It may be here mentioned that the tensile properties of aluminium are increased by rolling, hammering, or drawing. In testing wires, therefore, different results may be obtained from the same material by varying the amount of drawing down. Copper and nickel-copper alloys can give about 20 tons breaking load, 16 tons limit of elasticity, percentage extension ·19 with 7·2 tons per sq. in. applied, and conductivity about 52 per cent. of copper. Now, hard-drawn copper has a breaking load of about 28 tons, and limit of elasticity 12 to 13 tons per sq. in., a percentage extension of 0·10 with 7·2 tons applied per sq. in., and a linear coefficient of about ·000017 per 1° C. These light aluminium alloys can have a limit of elasticity exceeding that of copper, their percentage extension under a given load within the limit of elasticity is greater (about twofold) than copper, and the linear coefficient of expansion is greater. The properties of the elastic catenary, together with the superposed effect of change of temperature, have been examined, and they show that the greater lightness and greater percentage extension counteract the effects of greater lineal coefficient of expansion. In fact, the factor of safety with regard to the elastic limit is greater than in copper under the same conditions.

Wind Pressure.—The Board of Trade regulations require a factor of safety of 6 for aerial lines, taking the maximum wind pressure at 50 lbs. per sq. ft. In a copper wire 0·4 in. in diameter, the resultant force per foot-length, due to gravity and such a wind pressure, may be double that due to gravity alone. With aluminium of the same conductivity, the wind pressure will be about 1·27 greater than with copper. Since the cross-sectional area of a wire varies as the radius squared, and the area exposed to wind pressure, snow, &c., varies as the radius, it follows that for a given material the larger the diameter the better. In other words, two separately strung wires of equal diameters are not so good as one wire of $\sqrt{2}$ the diameter of either the other two, although the total conductivities are the same in the two cases. But comparing aluminium with

copper, the total tensile strength of an aluminium wire of the same conductivity as the copper may be greater according to the alloy chosen, and this may compensate for the increase in the surface exposed to wind, &c.

Surface Effect.—If the mathematical theory of Lord Kelvin be examined, it will be seen that, provided the electrical resistance to steady currents is the same in each wire of a series of non-magnetic wires of the same length, but of different specific resistances, and consequently different diameters, the increase in electrical resistance, due to frequency, is the same in each of the wires. It cannot therefore be urged against the larger diameter (1·27) of aluminium, as compared with copper, that this effect is increased. Indeed, the self-induction is reduced by the larger diameter of the aluminium for equal conductivity.

Electric Glow.—In the case of aerial wires between which exists some thousands of volts potential difference, it is well known that the wires glow on account of the intense electrification of the air in the neighbourhood of the wire. This effect is a function of the radius of the wire. The mechanical pull varies as

$$\sqrt{(\text{field strength} \times \text{radius of curvature})}$$

for points (see Chattock, *Philosophical Magazine*, September, 1891). The increased radius of the aluminium for the same conductivity as copper would help to reduce electric glow. The film which forms on aluminium in the presence of moisture is known to consist of basic aluminium sulphate, and the author has found that it possesses a high electrical resistance when dry. This may have importance, in the case of overhead conductors, in diminishing glow discharge.

Some Long-Distance Transmissions.—A full description of all the long-distance transmission schemes would be out of the question here. The following are brief notes to give a general idea of what has been accomplished. At Northallerton, England, four miles of overhead aluminium wires are employed. Screwed socket joints have proved successful. At the Snoqualmie Falls, 20 miles of overhead conductors convey current to Renton, where the line divides, one half going to Seattle and the other to Tacoma. About 139,000 lbs. of aluminium are employed. The horse-power is 12,000 and the voltage is 30,000. McIntire joints are employed. This joint consists of a tube 9 in. long, of aluminium, flattened, and large enough to enclose both wires; by special clamping tools three complete twists are given and the joint is complete. The Blue Lakes transmission scheme has 43 miles of overhead wires. The poles are 132 ft. apart. The aluminium used in this undertaking has been referred to above. As indicating the satisfaction given by aluminium, it may be mentioned that in the new line about 1,000,000 lbs. of aluminium will be required in the form of stranded conductors, $\frac{3}{4}$ in. in diameter. The Pittsburg Reduction Company have received orders for 150,000 lbs. of aluminium for the feeders on the North-Western Railway, Chicago. The Hartford Electric Light Company have 33 miles transmission, 2,000 H.P. at 10,000 volts, three-phase. The cable, $\frac{7}{8}$ in. in diameter, consists of seven strands. The Kansas City and Leavenworth Electric Railway line are using 76 miles of aluminium cable. At Waterport, U.S.A., a 6½ miles transmission is employed. The conductor consists of a seven-strand cable supported on 30-ft. poles 100 ft. apart. The Niagara Falls Power Company has about completed its second power transmission line between the Falls and Buffalo. The three-phase current is transmitted by three aluminium cables, each composed of 37 strands. The span between the poles, which in the old copper lines is 75 ft., averages 112½ ft. in the aluminium line. An electrical transmission plant has been completed in the valley of Pompeii, near Naples, in which aluminium is employed for the line wires. Three lines emanate from the power house—2 miles, 9 miles, and 2 miles long respectively. In Provo Canyon, three aluminium cables, each of seven strands, transmit over 40 miles to Tintic, which is connected with Mercur, 30 miles distant, and electric current is transmitted to Mercur *viâ* Tintic, as readily as by the direct line between Mercur and Provo. In this manner, if one line is out of order, power can be transmitted by the other.

Joints.—It has been urged against aluminium that it gives trouble in jointing. The ordinary metals are strongly electro-negative to aluminium, so that if other metals than aluminium be used in jointing, galvanic action will occur in the presence of moisture. In the above power transmissions mechanical joints have been made with success; but, with proper precaution, aluminium wire can be welded either by the use of the blow-lamp, or electrically. The following tests will show that welding can be successfully accomplished. The original trolley wire (8 section) has an area of ·135 sq. in., and a breaking load of 1·6 tons on that section, with 11·3 per cent. extension. The welded joint gave 1·2 tons breaking load, with 8 per cent. extension, the joint not being broken. An aluminium wire, ·516 in. in diameter, having a breaking load of 3,449 lbs., with 14 per cent. extension, gave 2,912 lbs. breaking load, when welded with 20 per cent. extension. Hard and soft solders are supplied by the British Aluminium Company. It is necessary to break up the oxide which forms on the surface of the aluminium, and with care aluminium soldering is rendered easy.

Melting and Casting.—Aluminium can be melted in plumbago or sand crucibles without becoming brittle or taking up silicon, provided that the temperature does not much exceed 626° C., or 1,160° F., its melting point. The shrinkage of pure aluminium is ·20 in. to the foot, as compared with ·187 in. for copper.

Aluminium for Iron and Steel Founders.—The addition of aluminium to iron or steel has the great advantage of keeping the metal more fluid in the ladle, thus saving by the avoidance of blowholes. At high temperatures the metal decomposes nearly all metallic oxides, and prevents blowholes by combining chemically with the gas which forms the holes. Its action is stated to be about 20 times as powerful as silicon, and the resultant steel is superior in toughness and ductility. The quantity to be added varies according to the iron used. Generally the amount runs from 2 lbs. to 5 lbs. per ton of iron.

Rolling and Forging.—The great ductility of aluminium makes it easy to work with rolls. Rolled sheet aluminium, ·001 in. thick, is used for decorative purposes. In fact, leaf aluminium may be said to have replaced leaf silver. It can be forged easily either cold or warm. Aluminium containing much silicon and iron can only be forged with greater difficulty.

Hardening and Annealing.—The hardness of aluminium varies according to its purity, the purest metal being the softest. Ordinary 98 per cent. aluminium is about as hard as copper. Aluminium becomes harder the more it is worked by rolling, drawing, stamping, or hammering. The metal must be annealed in a close muffle, and must not come in contact with the open fire.

Drawing and Stamping.—Prof. Thurston places aluminium as sixth in the order of ductility, being preceded by gold, silver, platinum and copper, but it is doubtful if it does not rank as high as iron. Aluminium can be pressed or stamped under the drop hammer, hot or cold. Very fine effects can be produced by first burnishing the metal and then stamping in polished dies.

Heavy Alloys—Aluminium Bronzes.—In 1889 and 1890 papers were read before this Section on aluminium bronzes. It was then pointed out by Mr. J. H. J. Dagger, F.C.S., F.I.C., that for artillery, small arms, propeller blades, stern rudder frames and hydraulic work, the non-corrodible properties and great strength of these alloys rendered them most valuable. Aluminium bronze propellers have been successfully employed for high-speed torpedo catchers. The two classes of bronze most frequently used contain from 12 to 8 per cent. aluminium and 88 to 92 per cent. copper, and have a golden appearance and the strength of steel. The breaking load in tons per square inch varies from 44 to 39, with an average elongation of 9 per cent. and 38 to 34 tons per square inch, with an average elongation of 21 per cent. They have high elastic limit and transverse strengths.

Where forgings or stampings are required, four classes of bronze are recommended, containing respectively 10, 7½, 5 and 2½ per cent. aluminium, the rest being copper. The specific gravities vary from 7·6 to 8·3, the tensile strength varies in castings from 30 to 20 tons per square inch, and the elongation varies from 22 to 40 per cent.

Uses of Pure Aluminium.—The uses of aluminium are very numerous. Probably the widest field is still in the purification of steel and iron. It appeals to the public as a material for construting cooking utensils. It is not brittle like cast-iron, nor does it rust like tinplate. It is used for internal fittings for ships instead of wood, for motor car parts, and boiling pans for confectionery. The Admiralty employ it, and on the Continent soldiers are equipped with it when possible. It is used in a modified form of lithography as a substitute for solenhofen. We have seen that with the increasing price of copper, aluminium is being used largely for conductors of electricity. It can be used for roofing houses. There is no reason why it should not be used to replace the present heavy bronze coinage. It wears beautifully bright and clean, and is sufficiently hard for this purpose.

CURRENT SPECIFICATIONS.

LXXVIII.—LEEDS SWITCHBOARD.

SUMMARY.

Extent of Contract.—Supply and fixing of new main switchboard for two-phase working.

Number of Machines and Circuits.—To be arranged for three 1,500-KW. two-phase 50 ~ alternators and 30 single-phase circuits.

Type of Board.—To be suitable for working in conjunction with the existing board, two main omnibus bars being provided. All switches to be single-pole, connected to the inners of the concentric cables. The handles of each pair of switches to be coupled together so that the two phases are operated together.

Size of Switchgear.—Alternator switchgear to be capable of carrying 500 amperes, each circuit 200 amperes as working current.

Tests after Completion.—Flash test of 5,000 volts between omnibus bars and earth, all instruments in circuit, also a continuous test of 4,000 volts for one hour.

Details of Offer.—The plant and apparatus offered to be fully described on the blank pages attached to the specification.

Specified Date of Completion.—Seven months from date of order.

Penalty for Late Completion.—One-half of 1 per cent. off total contract price per week.

Terms of Payment.—80 per cent. of value of work executed on site as work progresses, 10 per cent. three months after work taken over, 10 per cent. six months later.

Period of Maintenance.—Until date of final payment, nine months from date of completion.

Amount of Surety.—Two sureties to be named willing to be bound in a sum equal to 80 per cent. of contract price.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be Paid to Workmen.—See below.

Arbitration Proposals.—Unsatisfactory, see notes below.

Date for Receipt of Tenders.—October 8th, 1901.

This specification is issued by the town clerk, and signed by Mr. H. Dickinson, A.M.I.C.E., M.I.E.E., the engineer of the undertaking.

In some respects it is of special interest in view of the controversy which has arisen in regard to the placing of the contract for somewhat similar apparatus by the Corporation of Manchester with a foreign firm.

So far as relates to the technical part of this specification, the requirements can be met by any firm who do high-class work and make a speciality of high tension switchgear.

The engineer knows what he wants, states his wishes clearly, and asks tenderers to specify in detail how they propose to meet the requirements. The generators are two-phase 1,500-KW. machines, the circuits single-phase, and it must be possible to work the circuits in pairs, one on each phase, together. The machines must be capable of working in parallel, and the board throughout is of the single-pole parallel-working variety, the alternator and circuit panels being placed on opposite sides of a brick partition.

It will be noticed that in accordance with modern practice the construction of the board is to be such that it is perfectly fireproof in every detail.

The general conditions demand that two sureties shall be found by the successful tenderer who shall be willing to be bound in a sum equal to 80 per cent. of the contract sum. This seems excessive, the needs of the case would surely be met if 20 or, at the most, 50 per cent. were asked for.

The special point needing attention when preparing offers is the absence of any provision for arbitration. The decision of the engineer is throughout specified to be final, not only in interpreting the wording of the different clauses, but also in settlement of any dispute. It is further stipulated that any such decision shall be made a rule of the High Court of Justice on the application of either party to the contract. We consider this to be entirely unfair, and we strongly recommend that exception be taken to this in tendering, the reference of all disputes to an independent arbitrator being stipulated for. It is only by united action on the part of manufacturers that a stop can be put on the attempts of wealthy and powerful municipal authorities to ride roughshod over the sound and just commercial principle of the settlement of disputes by an independent unbiassed authority.

The labour clauses are very stringent, and provide for the payment of standard rates of wages in the districts in which the work is carried out, the observance of the standard hours of labour, and the transfer of their liabilities to all sub-contractors. These conditions will doubtless be accepted by many of the leading firms, but we think they will strongly object to the conditions providing for the production at any time to the nominee of the town clerk or deputy town clerk of the private books of the contractor, containing the times and payments of all wages to workmen in connection with the contract. We think demands of this character are unreasonable, and we strongly urge all tenderers to protest against any such stipulation. If it be allowed to pass unchallenged, and it become customary for any purchaser to demand that his nominee shall have access to the labour costs of any article he purchases, it will be liable to gross abuse, and will be a source of grave injustice. We hold that a municipal body is in the same position as any other purchaser, and that it has no right to force upon an unwilling manufacturer a number of special stipulations such as those mentioned above, simply because it is influential and powerful, and is able, by reason of this influence and power, to dictate terms to the contractor it employs.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this Journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

18,023. "Improvements in electric storage batteries." L. BRISTOL. September 9th.

18,027. "Improvements in electrical machines and motors." G. GUY. September 9th. (Complete.)

18,030. "Improvements in electrical apparatus for transmitting the speed of a rotating body to an indicator at a distance." A. U. ALCOCK. September 9th.

18,079. "Improvements in electric heating systems for cars." F. C. NEWELL and E. M. HERR. September 10th.

18,032. "An improvement in direct current generators or motors." H. E. DONNITHORNE. September 10th.

18,100. "Apparatus for registering telephone calls." H. SNOWDON. September 10th.

18,102. "Improved process for magnetically separating pulverised ores, sulphide or otherwise, from their gangue or from each other." A. F. SPOONER. (Magnetic Ore Separating Company Proprietors, Limited, Victoria.) September 10th. (Complete.)

18,105. "Improvements in coherers or detectors for electrical waves." G. MARCONI. September 10th.

18,110. "Improvements in connection with electrically-operated cranes and other electrically-operated machines or vehicles." J. BROWN & Co., LTD., T. J. TRESSIDER, and D. G. JONES. September 10th.

18,124. "Improvements in electrical switches." A. H. HICKLEY. September 11th.

18,125. "Improvements in and connected with electrical controlling switches." A. H. HICKLEY. September 11th.

18,155. "Improvements in electric circuits and electro-magnetic regulators." OTIS ELEVATOR COMPANY, LIMITED. (Otis Elevator Company, Incorporated, United States.) September 11th. (Complete.)

18,169. "Improvements in searchlights or projectors for naval and military purposes." CROMPTON & Co., LIMITED, R. E. B. CROMPTON, A. J. HODGSON, and J. W. EWART. September 11th.

18,179. "Improvements in electric cables." J. H. WEST. September 11th. (Complete.)

18,180. "Improvements in the manufacture of electric cables." J. H. WEST. September 11th. (Complete.)

18,228. "A method of testing the lines of electrical fire alarm, burglar and call systems." A. ECKSTEIN and F. G. BELL. September 12th.

18,246. "Improvements in and connected with magnetic separators." C. SCHOLL. September 12th. (Complete.)

18,256. "Improvements in electric accumulator batteries." M. J. B. A. COLLETAS. September 12th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 12th, 1901, being date of application in France.) (Complete.)

18,258. "Combined electric logs and speed recorders." F. N. DENNISON. September 12th.

18,267. "Improvements in or relating to detectors and so-called coherers for the detection of electrical disturbances, Hertzian waves, light waves, and other radiations." J. C. BOSE and S. C. BULL. September 12th.

18,268. "Improvements in or connected with electrical resistances." J. C. BOSE and S. C. BULL. September 12th.

18,273. "Improvements in methods of electric haulage and locomotion." G. CAWLEY. September 13th.

18,282. "Improvements in and relating to fittings for electric lamps or gas fittings, and the like purposes." H. COOKE. September 13th.

18,288. "Supporting and automatic disconnecting shackle for electric tramway cables and other electric traction work." W. H. STEWART. September 13th.

18,322. "A bond for making an electrical connection between the hub and the felloe and tyre of railway and the like wheels, having a wooden or other non-conducting body portion." A. H. JOHNSON. September 13th.

18,329. "Improvement in electric circuit breakers." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett, United States.) September 13th. (Complete.)

18,330. "Improvements in electric motor control systems." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. E. Case, United States.) September 13th. (Complete.)

18,331. "Improvements in systems of electric motor control." F. E. CASE. September 13th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 15th, 1901, being date of application in United States.) (Complete.)

18,332. "Improvements in electric rheostats." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. E. Case, United States.) September 13th. (Complete.)

18,350. "Improvements in or relating to arc lamps with contact weather hoods safety catch and wire rope attaching device." C. OLIVER. September 13th.

18,393. "An improved electric furnace." J. FARNSWORTH. September 14th.

18,395. "Improved system of operating and controlling electrical lifts." H. C. WALKER. September 14th.

18,400. "New or improved controlling apparatus for electrically operated or driven ammunition rammers." A. REICHWALD. (The firm of F. Krupp, Germany.) September 14th.

18,417. "Improvements in the manufacture of electrically insulating acid-proof materials and objects made therefrom." R. ABREY. September 14th. (Complete.)

18,428. "Improvements in systems of electric motor control." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (P. Farnsworth, United States.) September 14th. (Complete.)

18,430. "Improved means or apparatus for detecting or indicating light waves, Hertzian waves and other radiations." J. C. BOSE and S. C. BULL. September 14th.

18,437. "Improvements in incandescent electric lamps." J. W. FORSTER. September 14th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

24,673. "Improvements in electric clocks." J. Butcher. Dated December 11th, 1899. The train from a ratchet wheel to an escapement and balance is driven by the fall of a loose weighted arm having an extension which bears a pawl. A pin also on the extension of the weighted arm eventually completes the circuit of an electro-magnet by putting into contact the pin and strip terminals upon an arm which projects from the pivot of an arm bearing the armature. The armature being attracted, a third arm on the same pivot strikes the pin and so throws up the driving weight again. 7 claims.

24,701. "An improvement in the manufacture of submarine electric conductors." Siemens & Co. and W. Dieselhorst. Dated December 12th, 1899. Submarine conductors are formed of a conductor enclosed in a loose tube of gutta-percha formed round the conductor by a press having a core into which water or compressed air may be passed. When water is employed the tubular casing has to be afterwards dried. 1 claim.

24,717. "Improvements in fire alarm telegraph apparatus." B. J. B. Mills. Dated December 12th, 1899. Fire alarm telegraph apparatus is arranged so that each street box can send its particular call to the central station where it is registered, and at the same time, if the central be free, the call is repeated on to a "joker" circuit, by which it is re-transmitted to the different engine houses. The "joker" circuits are also arranged with telegraph keys so as to allow of signalling from the central to the engine houses, but these circuits are automatically cut when a street call is received. 26 claims.

24,723. "Improvement in the process of smelting ore and in electric furnaces therefor." F. E. Hatch. Dated December 12th, 1899. Iron ore mixed with lime and carbon or other material to be treated, is smelted by passing it over refractory electric resistances previously heated to incandescence by passage of electric current, but out of circuit while under the ore. 16 clams.

24,739. "Improvements in or relating to electric switches." W. Ely. Dated December 12th, 1899. Relates to quick-break switches, and particularly throw-over switches into which the second connection is made independently of the handle. 5 claims.

24,740. "Improvements in or relating to electric switches." W. Ely. Dated December 12th, 1899. Relates to quick-break switches, and particularly to switches in which the contact-arm may be thrown over to close a second circuit, or may be stopped in an intermediate position. 5 claims.

24,791. "Improvements in or connected with boxes or cases for containing switches and mechanism connected therewith for electrical traction." W. Kingsland. Dated December 13th, 1899. Electric railways and tramways with mechanically-operated switches. An inner removable casing is seated on the packing or liquid seal on the flange of the outer box, and is held by bolts through lugs on the inner and outer case. The switch mechanism of any suitable form in the inner case is connected by spring clips or the like to the conductors supported on the bracket so that the mechanism is enclosed and can readily be removed when required. The shaft of the switch is connected to the spindle of the tappet wheel or lever by a universal joint consisting of a plate with grooves at right angles on its opposite faces engaging ribs on the shafts to allow ready alignment and removal. 8 claims.